BIOLOGY AND CONTROL OF THE PLUM CURCULIO (Conotrachelus numphar Herbst) WITH SPECIAL REFERENCE TO CERTAIN PHENOLOGICAL DATA

By

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INTRODUCTION

For two centuries the plum curculio has been known to be destructive to stone fruits. There are reports of it destroying peaches, plums, cherries and nectarines as far back as the seventeenth century. It is also considered as a major pest of these fruits at the present time. In the southern states, where there are two broods annually, the curculio is considered the outstanding pest of peaches. Farther north, where only one brood occurs each year, the damage is not so serious, but in years favorable to its hibernation and reproduction it causes considerable damage to peaches and early summer apples. Quaintance and Jenne's [1] publication on the plum curculio contains the largest amount of information ever brought together in one publication on this insect, and their bibliography covers the literature up to 1911. The following remarks on the early workers and publications on the curculio are taken from their bulletin.

The curculio is described as being a serious pest of stone fruits as early as 1776, with serious damage occurring around Philadelphia and in New Jersey in 1750. During the first half of the eighteenth century many papers were published on the depredations of the curculio and suggestions made for its control. From 1885 to 1900 several prominent entomologists including S. A. Forbes, L. O. Howard, C. V. Riley, C. P. Gillette, C. S. Crandall, and others, made contributions to the knowledge of this insect. Since 1900 the entomologists in the United States Department of Agriculture and in a great number of state institutions have worked on its life history, seasonal activities and control. These results are published in various entomological and horticultural papers.

The first work on curculio from Maryland was reported by Quaintance in 1902. He conducted tests to determine the number of eggs deposited by an individual female. In 1908 he ran tests to determine the number of feedings and egg punctures made by different individuals.

In 1909 Symons[2] started experiments near Boonsboro, Md., to determine the effect of arsenicals on curculio, but inclement weather prevented any records from being taken. In 1919 Cory[3] made a survey of curculio damage in orchards and found that from 8% to 16% of apples on unsprayed trees and 1 1/2% to 15 1/2% of the peaches on unsprayed peach trees showed either egg or feeding punctures. Sanders[4] working on the curculio on the Eastern Shore of Maryland, found that there was only one brood of beetles around Berlin, Md., in 1928, and that the beetles were in the orchard on May 2 in large numbers. At the time the first beetles were collected in the orchard the petals were falling from the peaches.

The writer began investigations on the plum curculio in March 1928 at Hancock, Md., and the results of these investigations are reported in this paper.

EMERGENCE OF CURCULIO FROM WINTER QUARTERS AND THEIR ENTRANCE INTO THE ORCHARD

A knowledge of the date on which the curculios begin to emerge from their winter quarters and enter the orchard, and the period of time over which this emergence continues, is of vital importance in setting up control measures.

The beginning of the emergence of the curculio from hibernating quarters into the orchard is dependent upon the daily mean temperatures. Quaintance, Woodside[5] and Dozier and Williams[6], found that no curculios emerged until the daily mean temperature reached 55°. W. D. Whitcomb[7] found that curculios kept at a constant temperature of 55°, remained sluggish, did little eating and laid very few eggs.

Records kept over a period of seven years by the writer shows that a daily mean temperature of 55° or above is necessary for from one to three days before emergence starts in cultivated orchards. However, in one uncultivated orchard containing large piles of brush and rocks, curculios were collected when the daily mean temperature was 49°. This seems to indicate either that the beetles start moving around in their hibernating quarters several days before they are actually found in the orchard, or the adults hibernating in this orchard were exposed to the sun rays, which actually exposed them to a higher temperature than was registered on the hygrothermograph.

The time of entry of the curculio into the orchard was determined by spreading a large sheet, or a piece of canvas, beneath the tree (Figure I) and giving the tree a sudden jar.

If the curculios are present they will feign death and drop to the canvas where they will remain for a short while unless removed. This method has been used in southern states as an adjunct in their control.

The first jarring for curculios should always be done several days in advance of the date the curculios are expected to emerge. In 1928 the first trees to be jarred were on April 25. Trees were also jarred on April 26, 27, 28, 29 and 30 without collecting any curculios. The daily mean temperatures on these dates were 45°, 45°, 42°, 35°, 40°, 40°, and 56°, consectively. On May 1 two curculios were collected, when the temperature was 56°, and the same as on the day previous, giving two days with a daily mean temperature above 55° before any beetles were collected. At this time about one-third of the peach was exposed from the shuck. The regular shuck spray was applied four days later.

The peak of emergence occurred on May 22, or twenty-two days after the first curculios entered the orchard. The average daily mean temperature from the date of the first emergence until the peak of emergence was 63°. A total of 132 beetles were collected during the season. The entrance of curculio into the orchard in relation to the daily mean temperature during 1929 is shown in GRAPH I.

In 1929 trees were jarred on April 25, 26 and 27 before any curculios were collected. The temperatures on these days were 45°, 55°, and 58°, consectively. On April 28 3 curculios were collected and the temperature was 55°, giving three days with the daily mean temperature above 55° before any beetles were collected. At this time about one-half of the peach was exposed from the shuck. The shuck spray was applied two days later. May 2 was followed by several days of wet weather, and no more beetles were collected until May 7. No records were made after May 14 at which time the beetles were coming into the orchards in large numbers. The peak was reached in fourteen days after emergence started, and the average daily mean temperature up to this time was 56°. A total of 449 beetles were collected during the period the records were taken. The entrance of curculio into the orchard in relation to the daily mean temperature during 1929 is shown in GRAPH II.

In 1930 trees were jarred on April 25, 26, 27 and 28 before any curculios were collected. The daily mean temperatures on these days were 43°, 48°, 52°, and 59°consectively. On April 29 48 beetles were collected and the temperature was 57°, giving three days with the daily mean temperature above 55° before any beetles were collected. At this time the petals had been falling for two days. The temperature, during the next several days, was high and the curculios appeared in the orchard in large numbers. The peak was reached on May 3, or five days after emergence started. The

The average daily mean temperature from the day emergence started until the peak was 63°. The total number of beetles collected during the period records were taken was 693. The entrance of curculio into the orchard in relation to the daily mean temperature during 1930 is shown in GRAPH III.

In 1931 trees were jarred on April 27, 28, 29, 30, and May 2, 3, 4, 5 and 6 without collecting any curculios. The daily mean temperatures on these dates were 42°, 49°, 52°, 45°, 49°, 50°, 48°, 49°, and 57° consectively. The first curculios were collected on May 7, and the temperature was 57°, giving two days with the daily mean temperature above 55° before any beetles were collected. At this time about one-half of the peach was exposed from the shuck, and the regular shuck spray was applied five days later. The peak of emergence occurred on May 14, seven days after the first curculios were collected. The average daily mean temperature from the day emergence started until the peak was reached was 56°. The total number of beetles collected during the time records were taken was 108. The entrance of curculio into the orchard in relation to the daily mean temperature during 1931 is shown in GRAPH IV.

In 1931 jarring records were also made in an orchard grown up with underbrush and containing large piles of brush and stones. Trees were jarred on April 27, 28, 29, 30 and May 1, and no beetles found. The temperatures on these dates were 42°, 49°, 52°, 45°, and 47° consectively. On May 2 16 curculios were collected and the temperature was 49°. This was the first instance in which curculios were collected before the daily mean temperature reached 55°. At this time the peach trees had been in full bloom for two days. The peak of emergence occurred on May 8, six days after the first beetles were collected in the orchard, and one day after the first beetles were collected in the cultivated orchard. The average daily temperature from the emergence of the first beetles until the peak was reached was 52°. The total number of curculios collected during the period that records were kept was 521. The entrance of curculio into the orchard in relation to the daily mean temperature during 1931 is also shown in GRAPH IV.

In 1932 no records were kept on the emergence of curculios from their winter quarters into the orchard.

In 1933 trees were jarred on April 26, 27, 28, 29 and 30 before any curculios were collected. The temperatures on these dates were 44°, 43°, 51°, 62° and 61°, consectively. On May 1 two curculios were collected and the temperature was 63°, giving three days with a daily mean temperature above 55° before any curculios were collected. At this time the shucks were splitting on the peaches, and early apples were in full bloom. The peak of emergence occurred on May 22, twenty-two days after emergence started. The average daily temperature from the time emergence started until the peak was reached was 62°. The total number of curculios collected during the time records were taken was 89.

The entrance of curculio into the orchard in relation to the daily mean temperature during 1933 is also shown in GRAPH V.

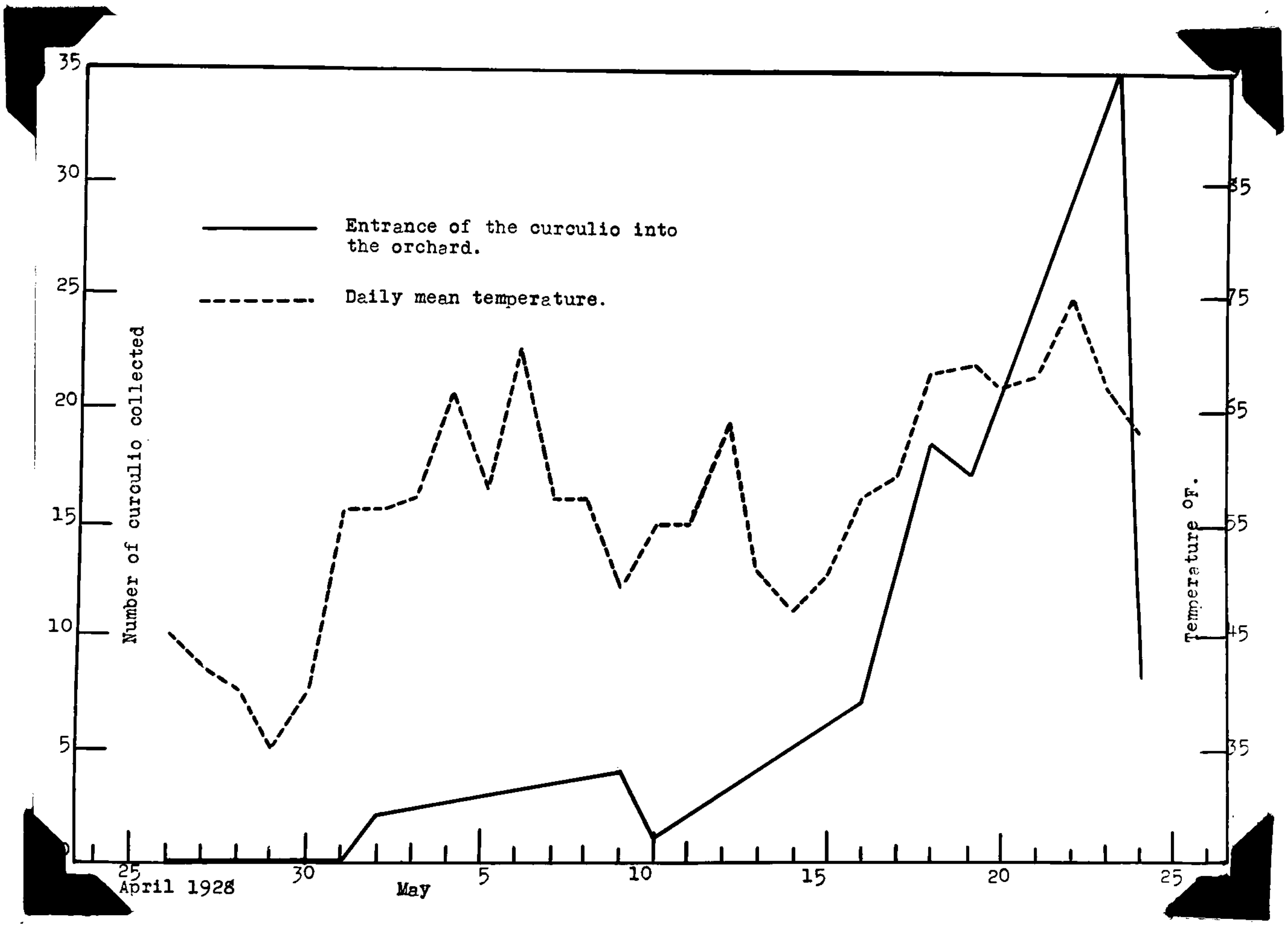
In 1934 the peach crop was practically frozen out and efforts to collect curculios from these orchards failed, even though the orchards were heavily infested the previous year. Yellow Transparent apple trees were jarred on April 26, 28, 30 and May 2 before any curculios were collected. The temperatures on these dates were 46°, 41°, 54° and 58°, consectively. On May 3 two curculios were collected and the temperature was 53°, giving one day with a daily mean temperature above 55° before any curculios were collected. At this time the petals were off the apples and two-thirds of the shuck was off the peaches. The peak of emergence was May 8, six days after the emergence started. The average daily mean temperature from the time emergence started until the peak was reached was 62°. The total number of curculios collected during the time records were kept was 42. The entrance of the curculio into the orchard in relation to the daily mean temperature during 1934 is shown in GRAPH VI.

In 1935 York and Transparent apple trees were jarred on April 24, 25 and 26 before any curculios were collected. The temperatures on these dates were 53°, 57°, and 55°, consectively. On April 27 one beetle was collected and the temperature was 65°, giving three days with a daily mean temperature above 55° before any beetles were collected. At this time the Transparent apple trees were in full bloom and the petals were falling from the peach trees. The peak of emergence was May 20, twenty-six days after emergence began. The average daily mean temperature from the time emergence started until the peak was reached was 57°. The total number of beetles collected during the time records were kept was 182. No jarring was done from May 4 to May 13 due to rainy weather. The entrance of curculio into the orchard in relation to the daily mean temperature during 1935 is shown in GRAPH VII.

In 1936 curculios in peach orchards were scarce, but were found to be fairly plentiful in a block of interplanted Transparent and York apple trees. Trees were jarred in this block on April 25, 27, 28 and 29 before any curculios were collected. The temperatures on these dates were 45°, 49°, 54°, and 55°, consectively. On April 30 four beetles were collected and the temperature was 62°, giving two days with the daily mean temperature above 55° before any curculios were collected. At this time the peaches were in full bloom and a few of the petals were falling (Figure 2). Transparent apples were in full bloom (Figure 3), and York Imperial apples were just beginning to bloom (Figure 4). The peak of emergence occurred on May 8, nine days after the beetles began to emerge. The average daily temperature from the time of first emergence until the peak was reached was 62°. The total number of curculios collected during the time records were kept was 125. The entrance of curculio into the orchard in relation to the daily mean temperature during 1936 is shown in GRAPH VIII.

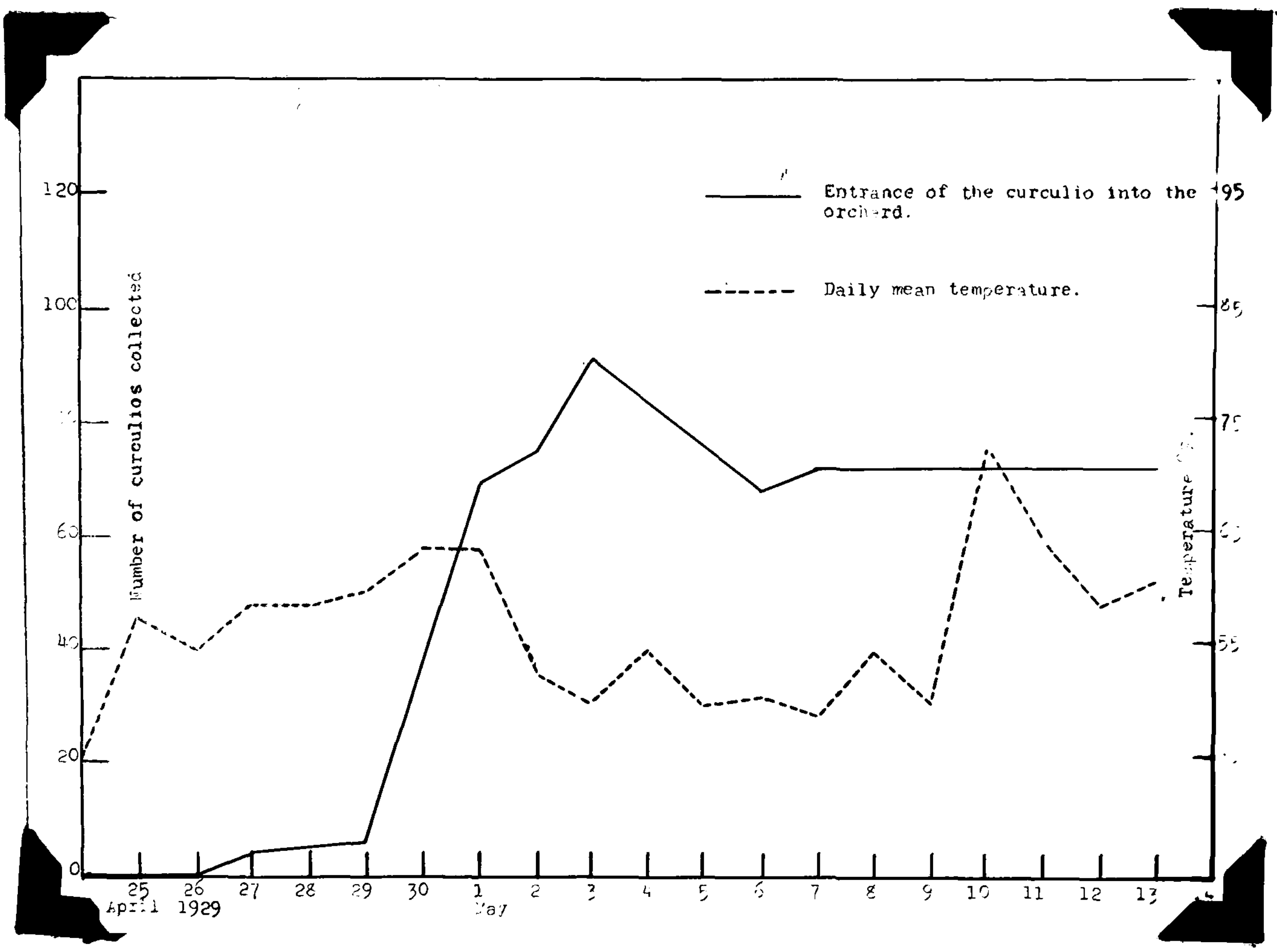
The outstanding fact in the data just presented is that a daily mean temperature of above 55° is necessary from one to three days before the curculio emerge from its winter quarters and enter a sprayed and cultivated orchard. Further data on the relation of temperature to the emergence of the curculio from its hibernating quarters show that the averages of the daily mean temperature from April 20 until the date on which approximately 50% of the hibernating curculios have entered the orchards over a period of eight years does not vary more than two degrees regardless of the date on which the emergence has reached 50% of the total. These data covering the period from 1928 to 1936 are shown in GRAPH IX.

GRAPH I



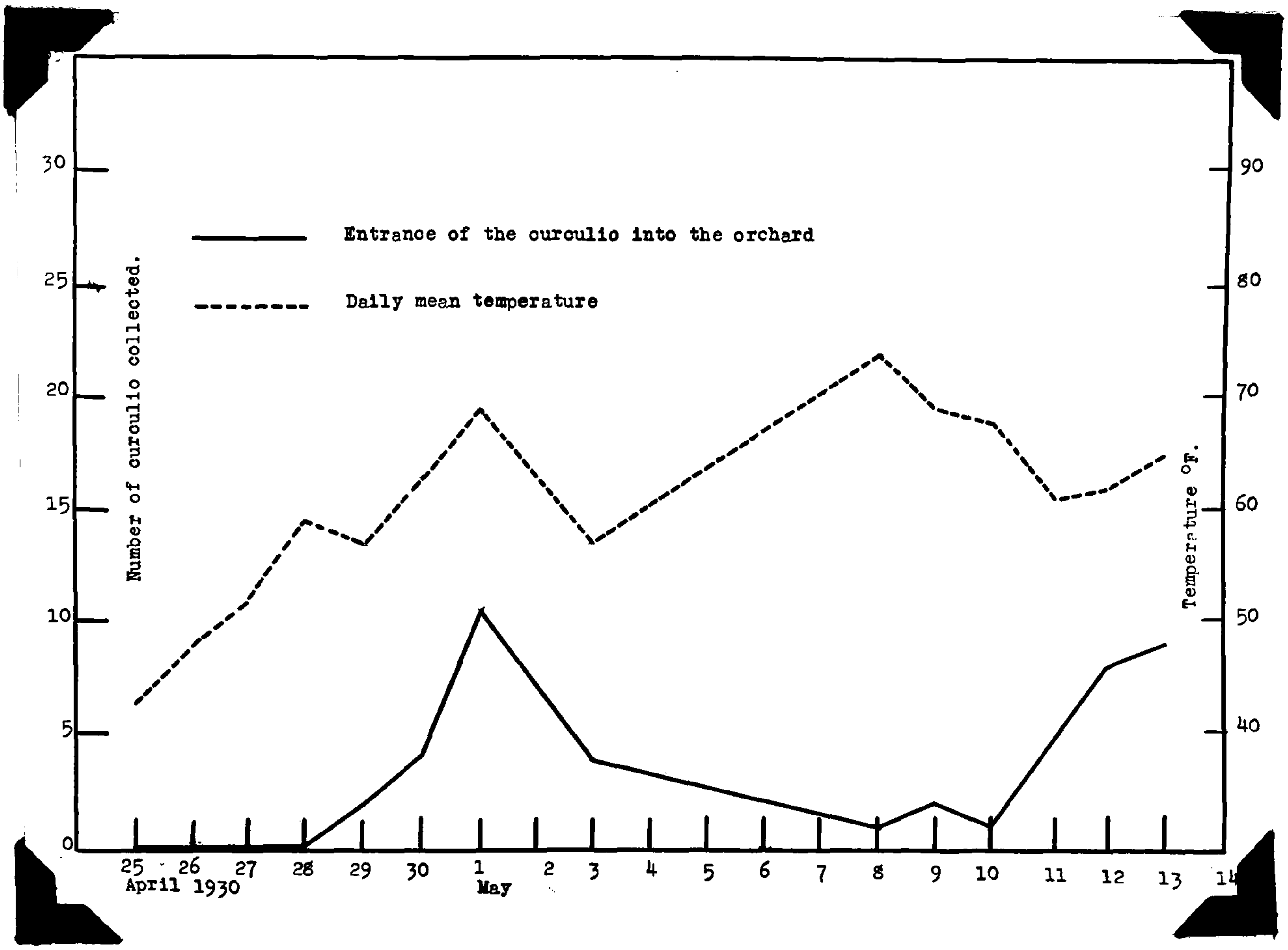
The relation between the daily mean temperature and the entrance of the hibernating curculio into the orchard during 1928.

GRAPH II.



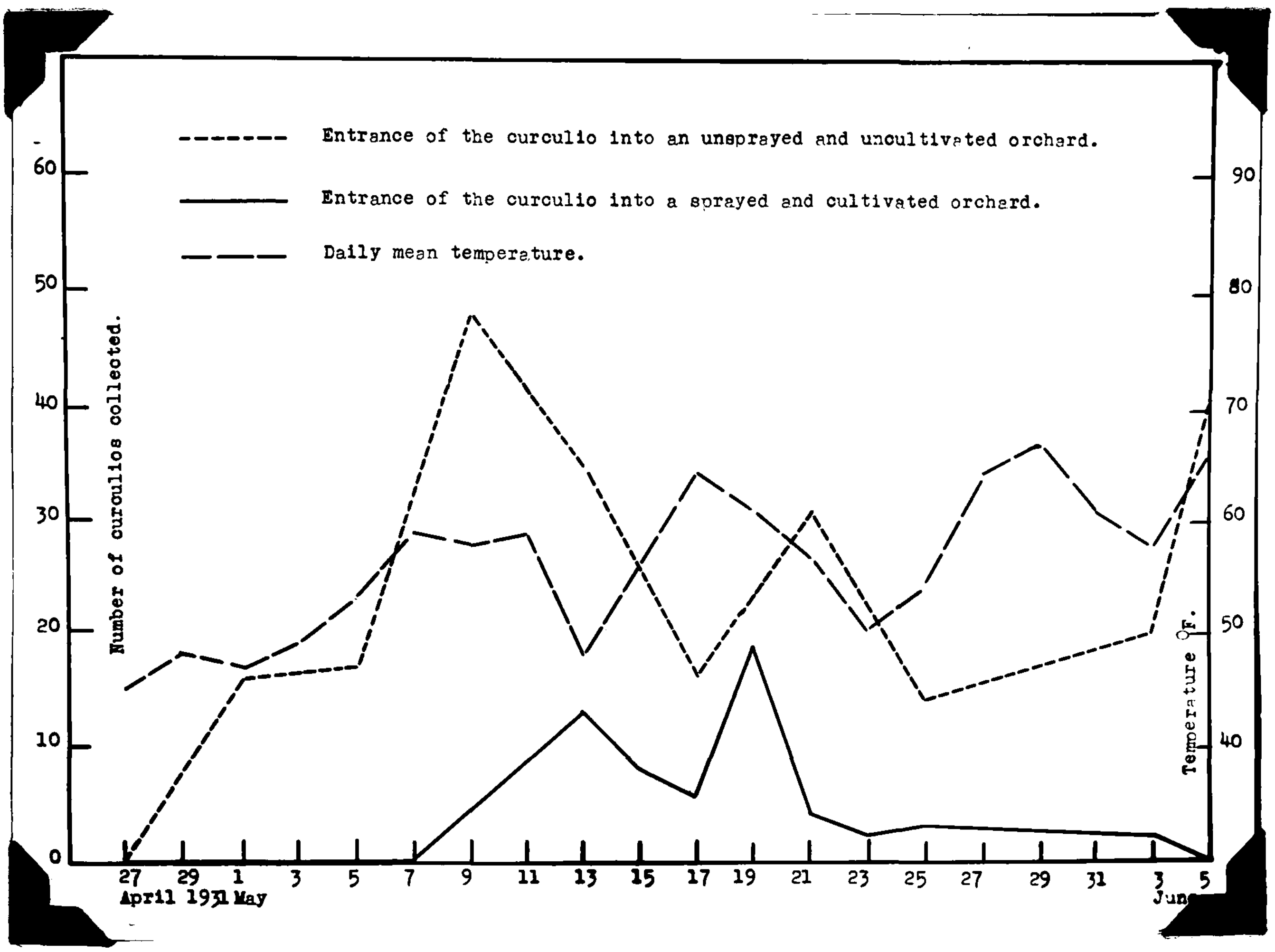
The relation between the daily mean temperature and the entrance of the hibernating curculio into the orchard during 1929.

GRAPH III.



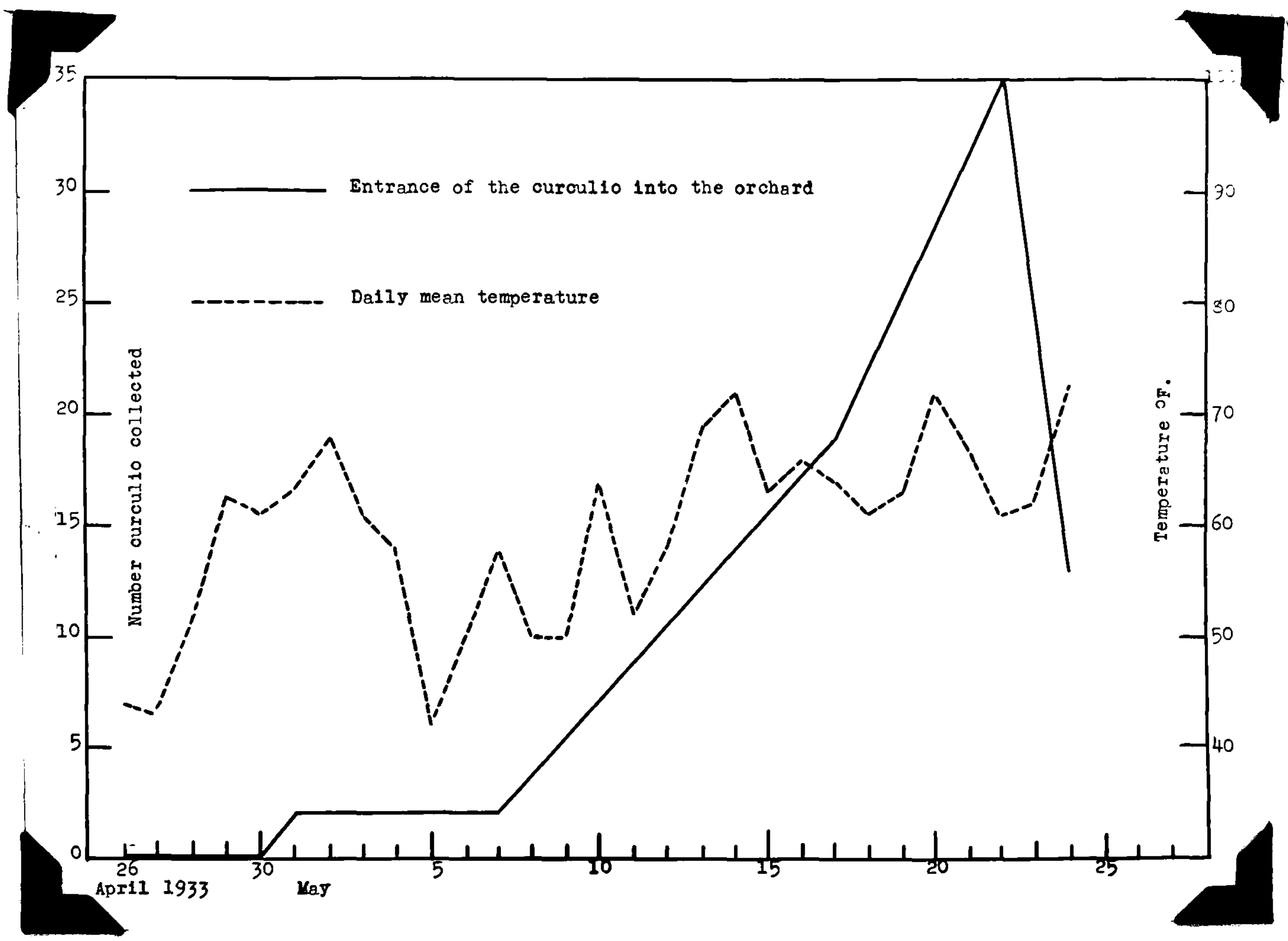
The relation between the daily mean temperature and the entrance of the hibernating curculio into the orchard during 1930.

GRAPH IV.



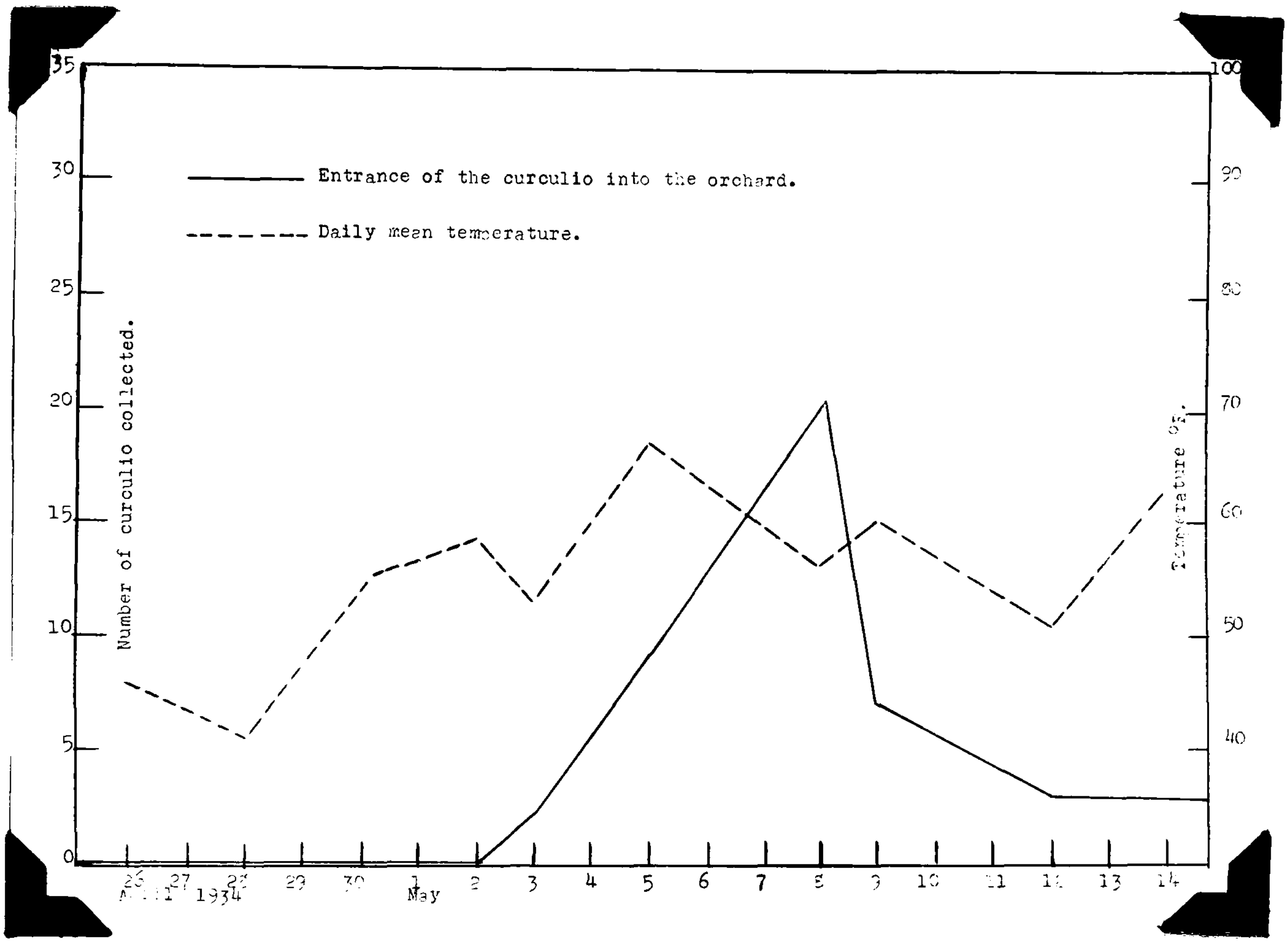
The relation between the daily mean temperature and the entrance of the hibernating curculio into a sprayed and cultivated and an unsprayed and uncultivated orchard during 1931.

GRAPH V.



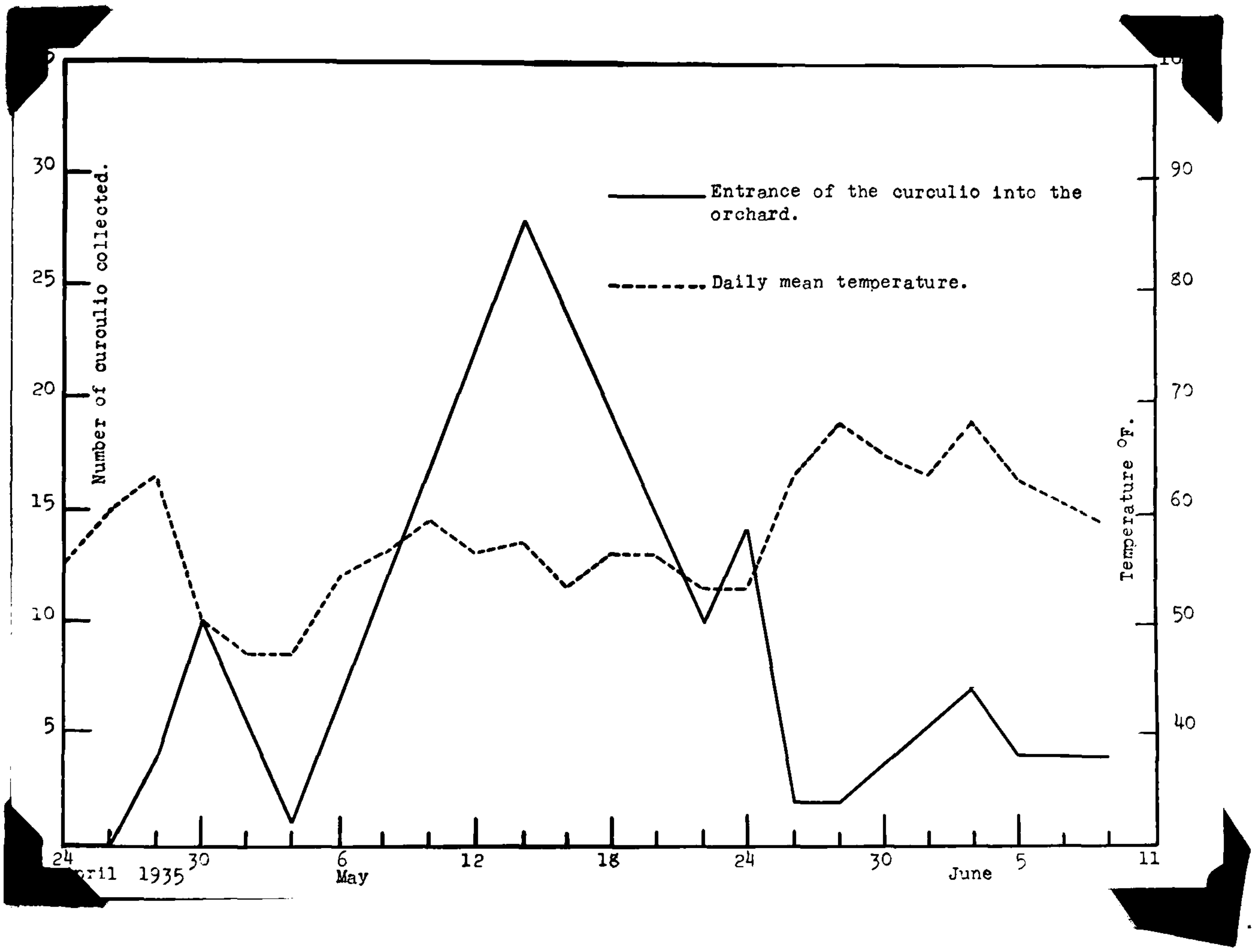
The relation between the daily mean temperature and the entrance of the hibernating curculio into the orchard during 1933.

GRAPH VI.



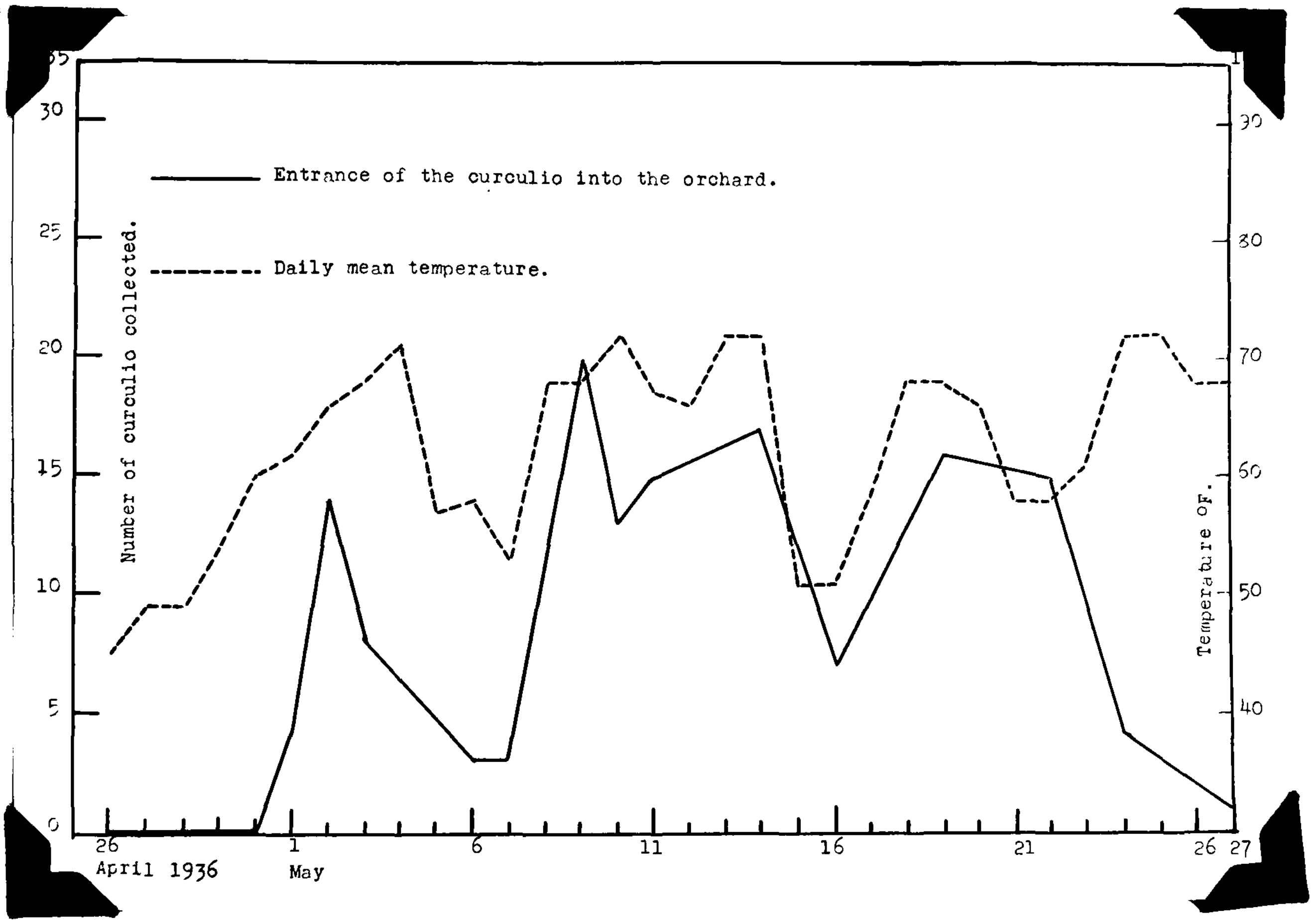
The relation between the daily mean temperature and the entrance of the hibernating curculio into the orchard during 1934.

GRAPH VII.



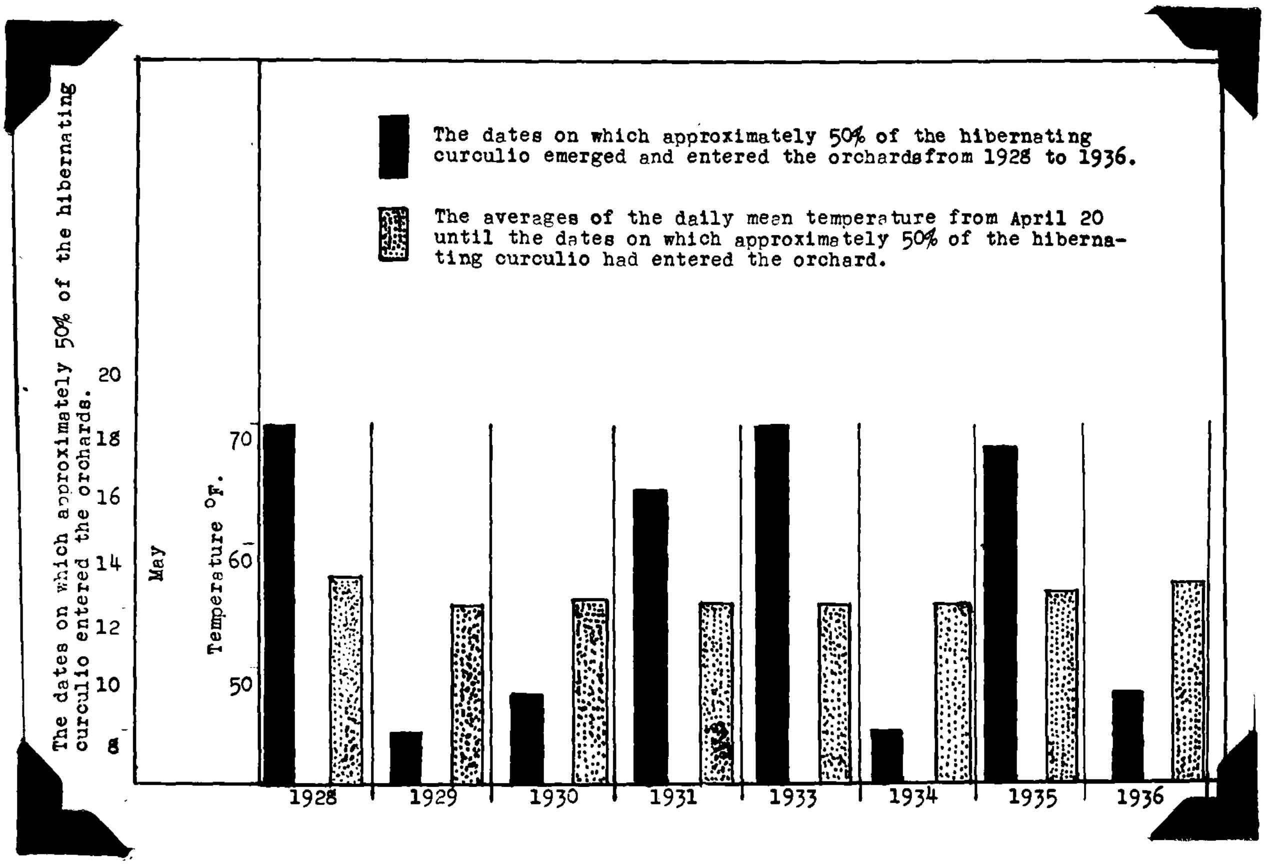
The relation between the daily mean temperature and the entrance of the hibernating curculio into the orchard during 1935.

GRAPH VIII.



The relation between the daily mean temperature and the entrance of the hibernating curculio into the orchard during 1936.

GRAPH IX.



The dates on which approximately 50% of the hibernating curculio entered the orchard, and the averages of the daily mean temperature from April 20 until the above dates, 1928 to 1936.

DISTRIBUTION OF CURCULIOS IN THE ORCHARD AT HANCOCK, MD.

The most important point to be cleared up in the control of curculios with arsenicals was the determination of the time the curculios began to enter the orchard and the length of time over which entrance into the fruit continued. The next important step was to determine the rapidity of the spread into the orchard from the curculio's winter quarters. This phase of their activities was determined by jarring trees adjacent to their hibernating quarters and other trees farther out into the orchard over a period of several weeks.

In 1932, four points for jarring were selected in a peach orchard, points 1, 2 and 3 were adjacent to the woods and point 4 near the center of the orchard. Several trees in each of these points were jarred on the same dates at different intervals from May 1 to June 11. The first jarring was on May 1. One beetle was collected at points 1 and 2. No beetles were collected at points 3 and 4. On May 8 two beetles were collected from point 2, and none from the other three points. On May 14 beetles were collected at all three points adjacent to the woods, but none were collected at point 4 until May 17. An average of 29 beetles were collected from each of the points adjacent to the woods, and only 2 from the center point. Curculios were collected from trees adjacent to the woods 17 days before any were collected at the center of the orchard. The results of jarring at the different points are shown in

GRAPH X.

In 1933 four points in a peach orchard were selected for jarring records. The points selected for jarring were located in the same manner as in 1932. Points 1, 2 and 3 were located adjacent to the woods, and point 4 was located in the center of the orchard. Trees were jarred at all four points at intervals from May 2 until May 23. An average of 11.3 beetles was collected from each of the three points adjacent to the woods, whereas no beetles were collected from the point near the center of the orchard. The results of jarring at the four different points are shown in GRAPH XI.

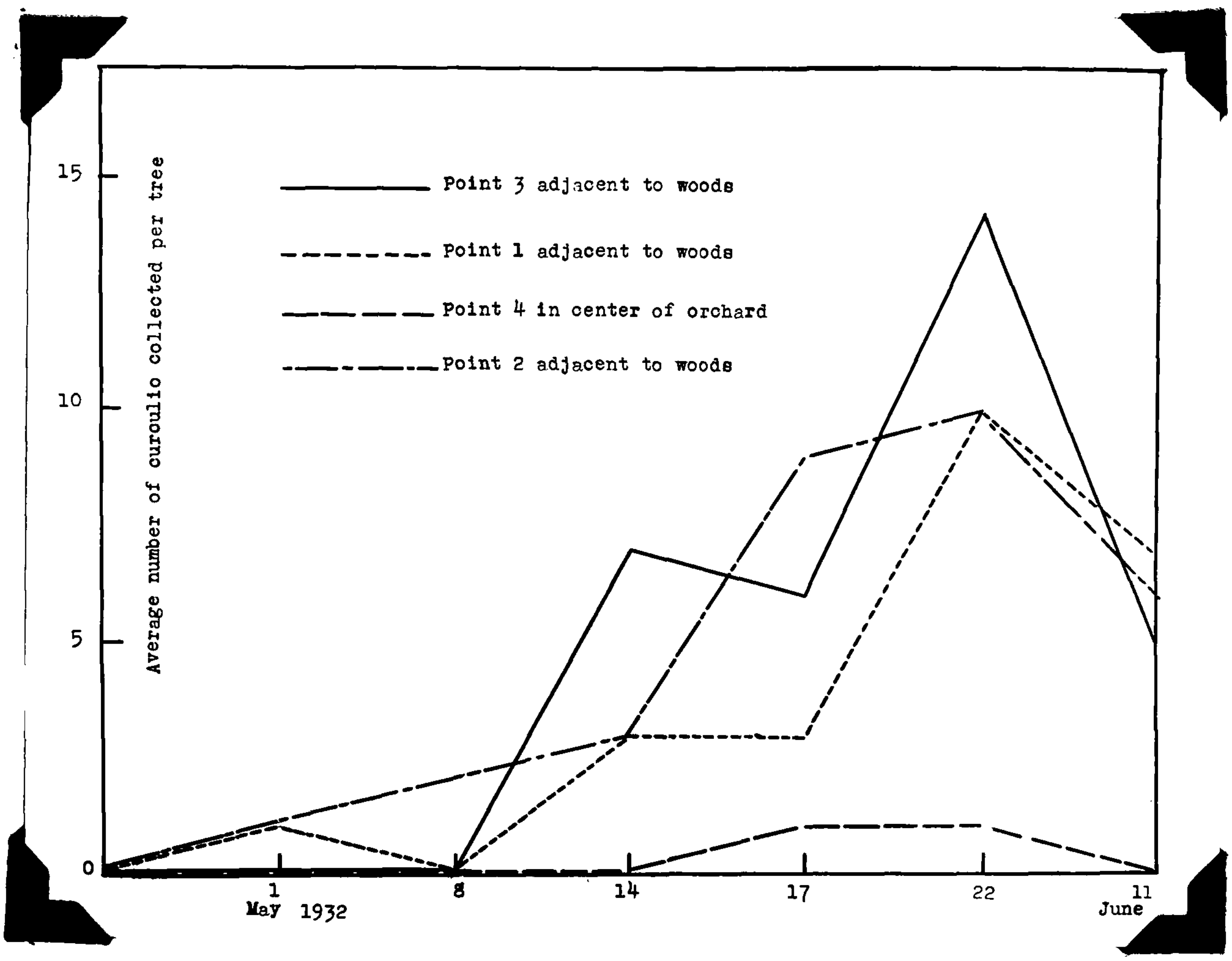
In 1934 the same procedure was carried out as in the two previous years, with jarring records kept in four points in a peach orchard, three of which were located adjacent to the woods, and the fourth in the center of the orchard. An average of 6 beetles was collected from each of the points adjacent to the woods, while none were collected from the point in the center of the orchard. The results of jarring at each of the four points are shown in GRAPH XII.

In 1935 records were made on the distribution of curculios into the orchard by jarring one Transparent and one York apple tree adjacent to the woods, and a Transparent tree about fifty yards out in the orchard. The first beetles were collected from the trees adjacent to the woods on April 29, and the first from the tree out in the orchard were collected on May 13, fifteen days later than the first were collected near the woods.

A total of 123 beetles were collected from the Transparent tree adjacent to the woods, 28 from the York tree adjacent to the woods, and 30 from the Transparent tree away from the woods. The peak of emergence on each of these trees occurred on May 20, twenty-one days after emergence started. A total of 181 beetles were collected during the time these records were taken. The results of the findings on the distribution of curculios from their hibernating quarters into the orchard are shown in GRAPH XIII.

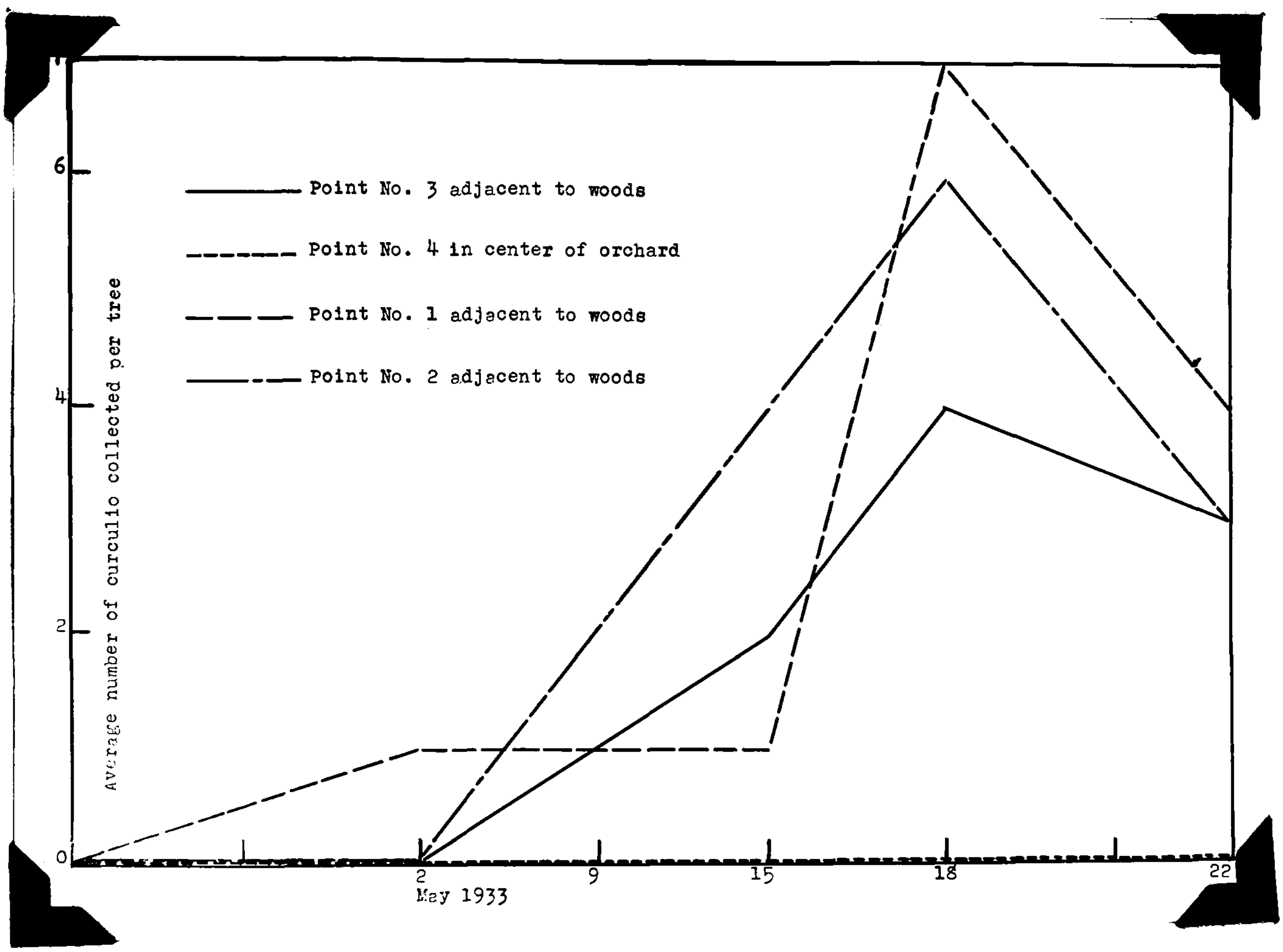
The procedure used in 1936 for determining the spread of curculios into the orchard was the same as in 1935, and was used in the same orchard. A Transparent and a York tree were selected near the woods, and a Transparent tree fifty yards out in the orchard. The first curculios were collected on the Transparent tree adjacent to the woods on April 30, the first collected on the York tree adjacent to the woods were on May 14, and the first to be collected from the Transparent tree out in the orchard were on May 1. On this same date 13 were collected from the Transparent tree adjacent to the woods. The peak of the collections from all three trees was May 14, fifteen days after the emergence started. A total of 100 curculios were collected from the Transparent tree near the woods, 8 from the York tree, and 17 from the Transparent tree fifty yards out in the orchard. The data on the distribution of curculios from their hibernating quarters into the orchard are shown in GRAPH XIV.

GRAPH X.



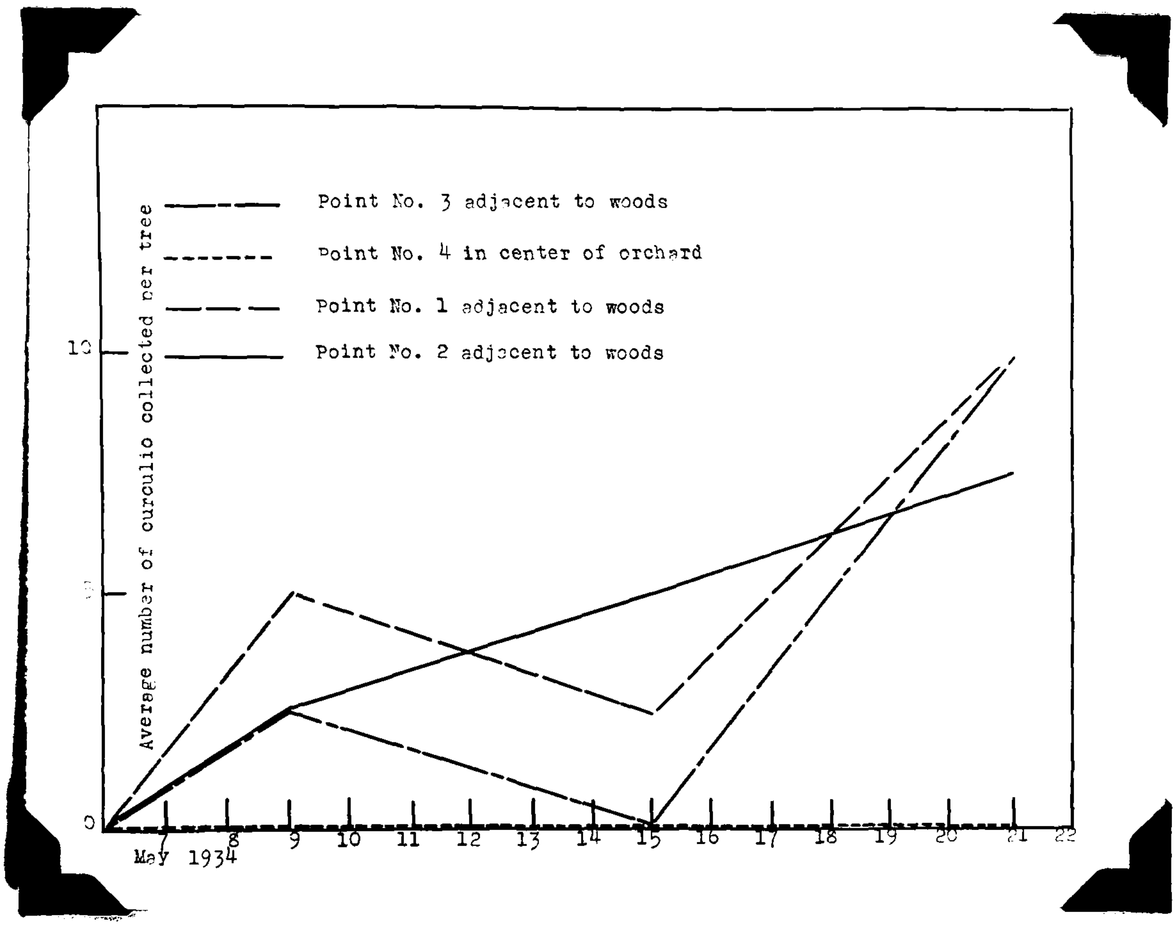
The distribution of curculios in the orchard after entering it from their winter quarters during 1932.

GRAPH XI.



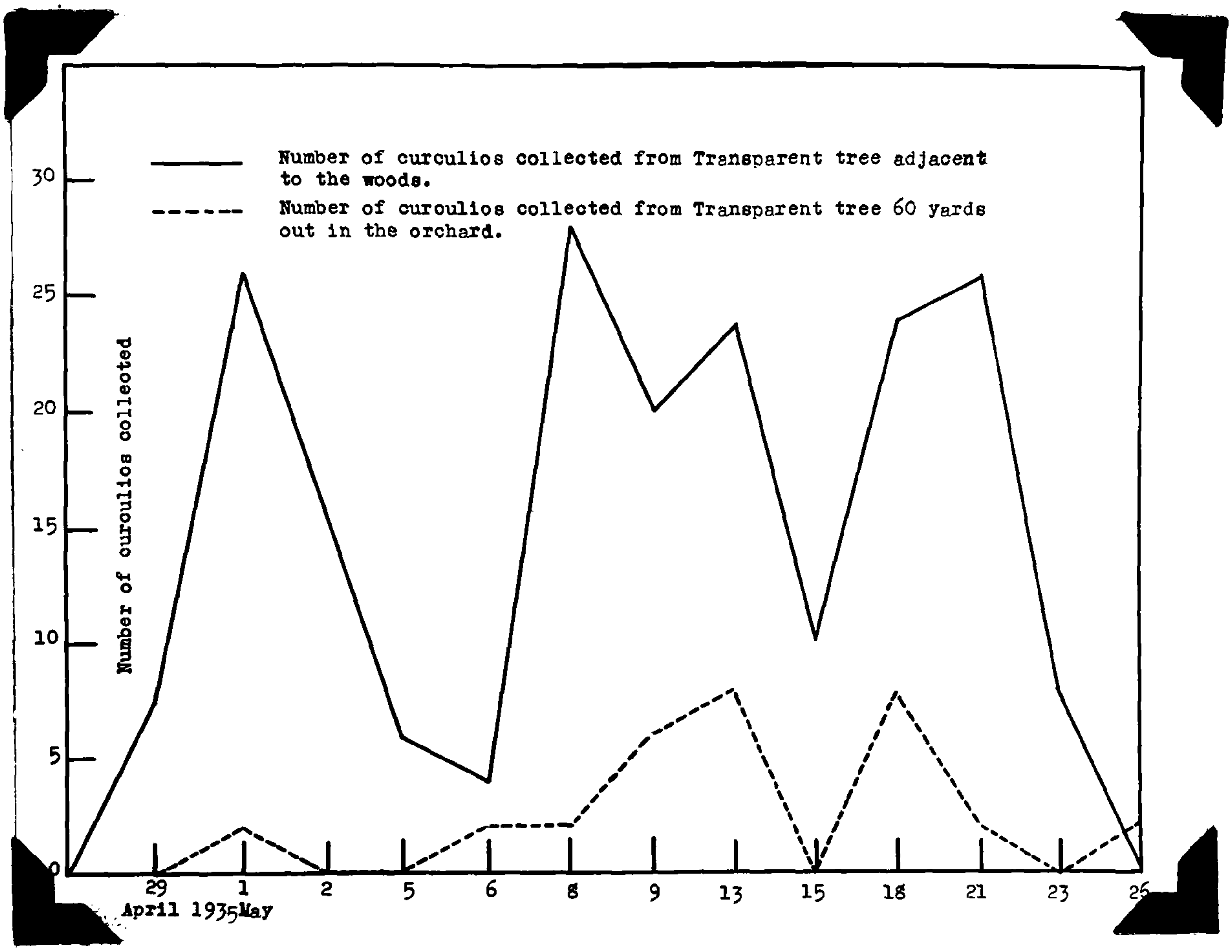
The distribution of curculios in the orchard after entering it from their winter quarters during 1933.

GRAPH XII.



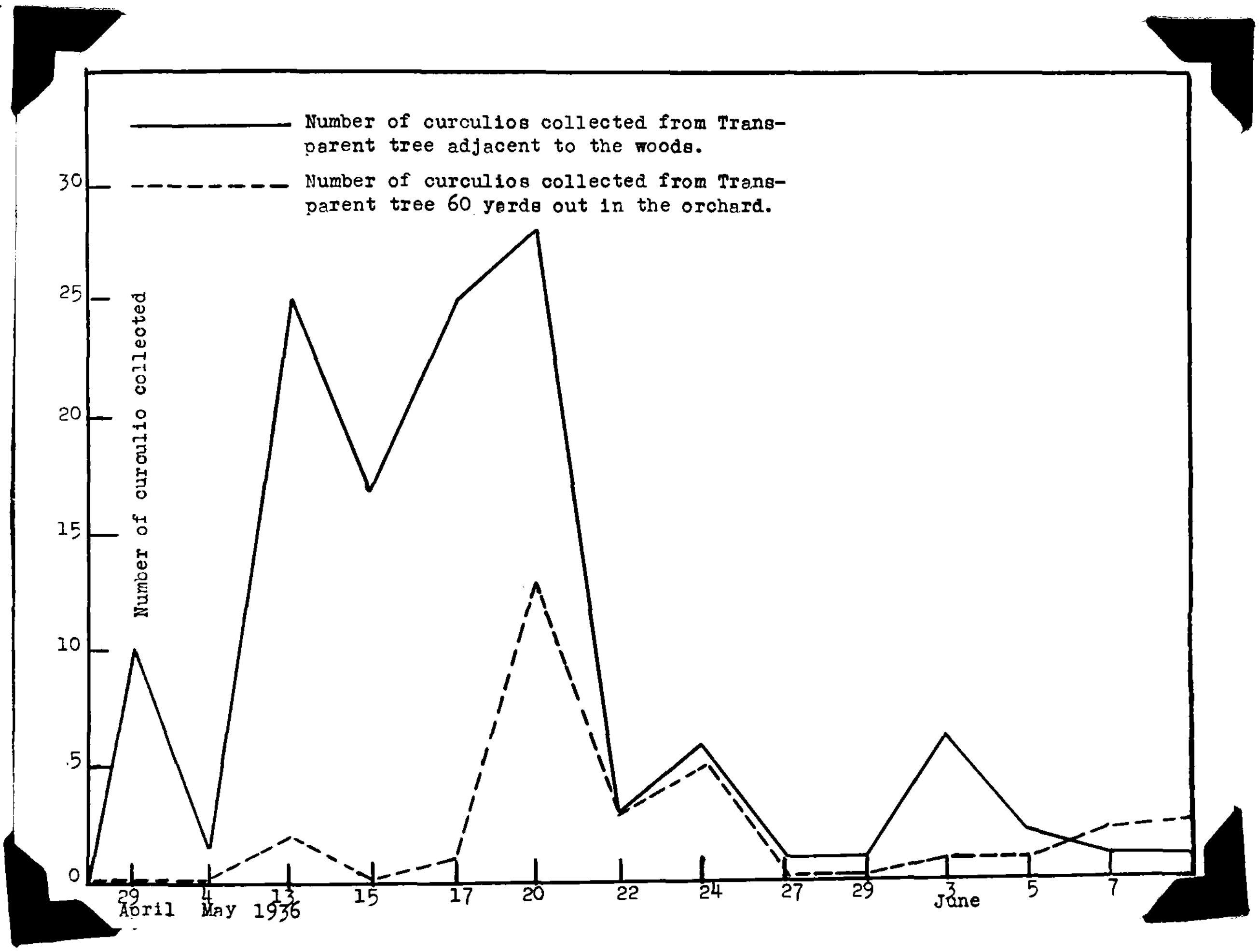
The distribution of curculios in the orchard after entering it from their winter quarters during 1934.

GRAPH XIII



The distribution of curculios in the orchard after entering it from their winter quarters during 1935.

GRAPH XIV.



The distribution of curculios in the orchard after entering it from their winter quarters during 1936.

OVIPOSITION HABITS OF THE CURCULIO

From the time the curculios first enter the orchards in the spring it is usually from one to two weeks before the peaches and apples are large enough to furnish a place for oviposition. Consequently the curculios remain in the orchard feeding until the fruit reaches the size suitable for egg deposition.

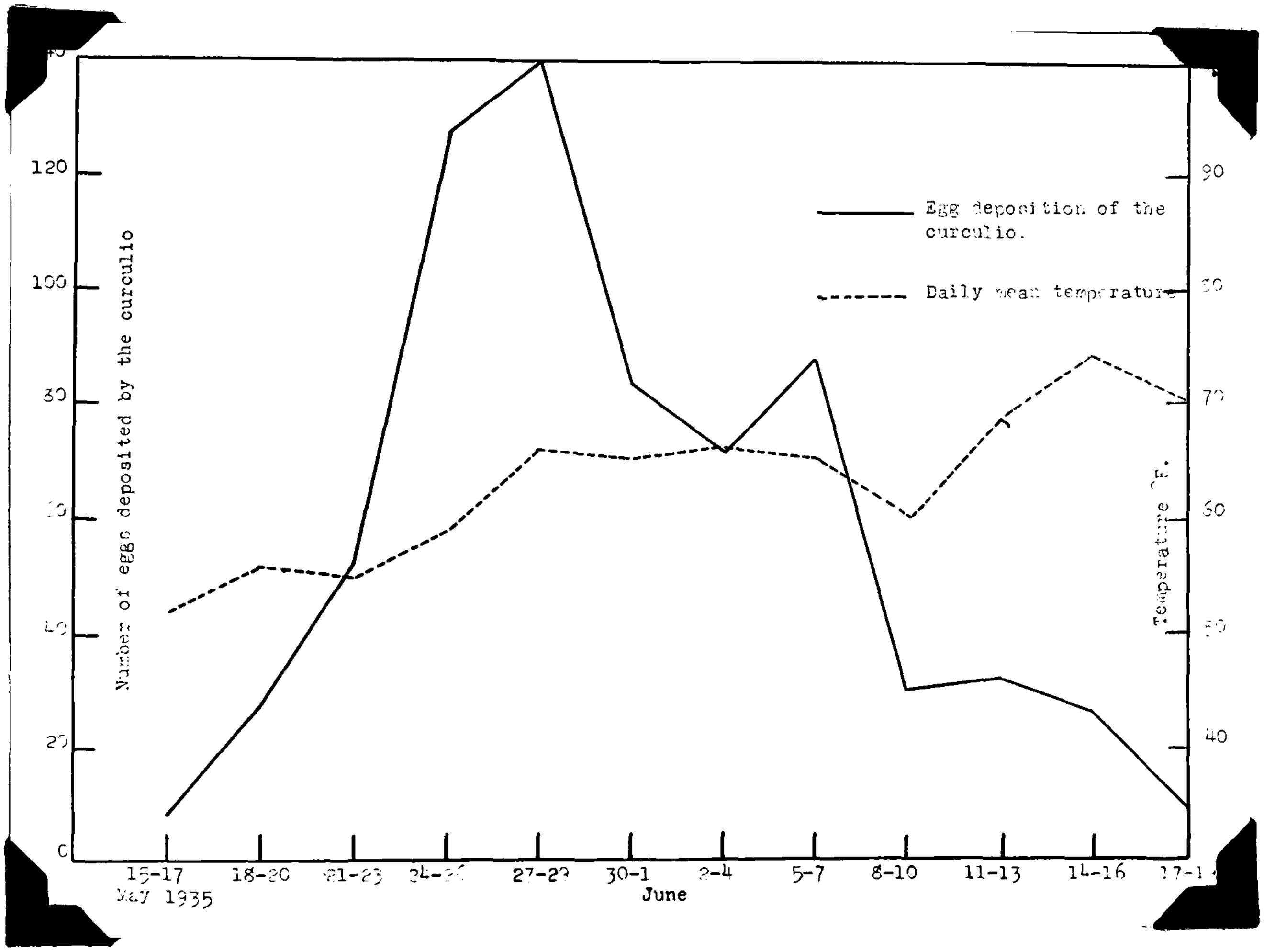
In 1936 tests were conducted to determine if the curculio would oviposit when it first emerged. This was done by placing the first beetles that emerged in a screen wire cage and immediately placing in the cage some apples from storage, some that had been outside all winter covered with damp leaves, and some canned cherries. The fruit was examined each morning for several days. Each morning eggs were found in the apples that had been covered with leaves, but none on the cherries and storage apples. Feeding punctures were numerous on the apples that remained outside all winter, but very few were found on the cherries and storage apples. The tenderness of the skin on the apples that remained outside probably accounted for the curculio ovipositing in them and not in the others.

The above observation indicates that the curculio would begin to oviposit immediately after emerging from winter quarters if a suitable oviposition medium was present.

In 1935 tests were conducted to determine the number of eggs laid by the individual curculio. Thirteen female beetles were selected and each beetle placed in a shell vial. Each morning the beetles were supplied with a small Transparent apple, or a piece of one large enough to slip into the vial. The curculios were prevented from escaping by a small piece of screen wire that fitted into the mouth of the vial. Each morning the apple was removed from each vial and the number of eggs in each counted, and a fresh piece of apple was placed in the vial. Records were kept on the number of eggs deposited by each beetle for a period of thirty-five days at which time practically all of the beetles had stopped laying. The records show that the minimum number of eggs deposited by a single curculio was 34, the maximum number was 92, with an average of 55.3. A total of 720 eggs were deposited by the 13 beetles. These figures are shown in TABLE I, and the relation of egg deposition to the daily mean temperature is shown in GRAPH XV.

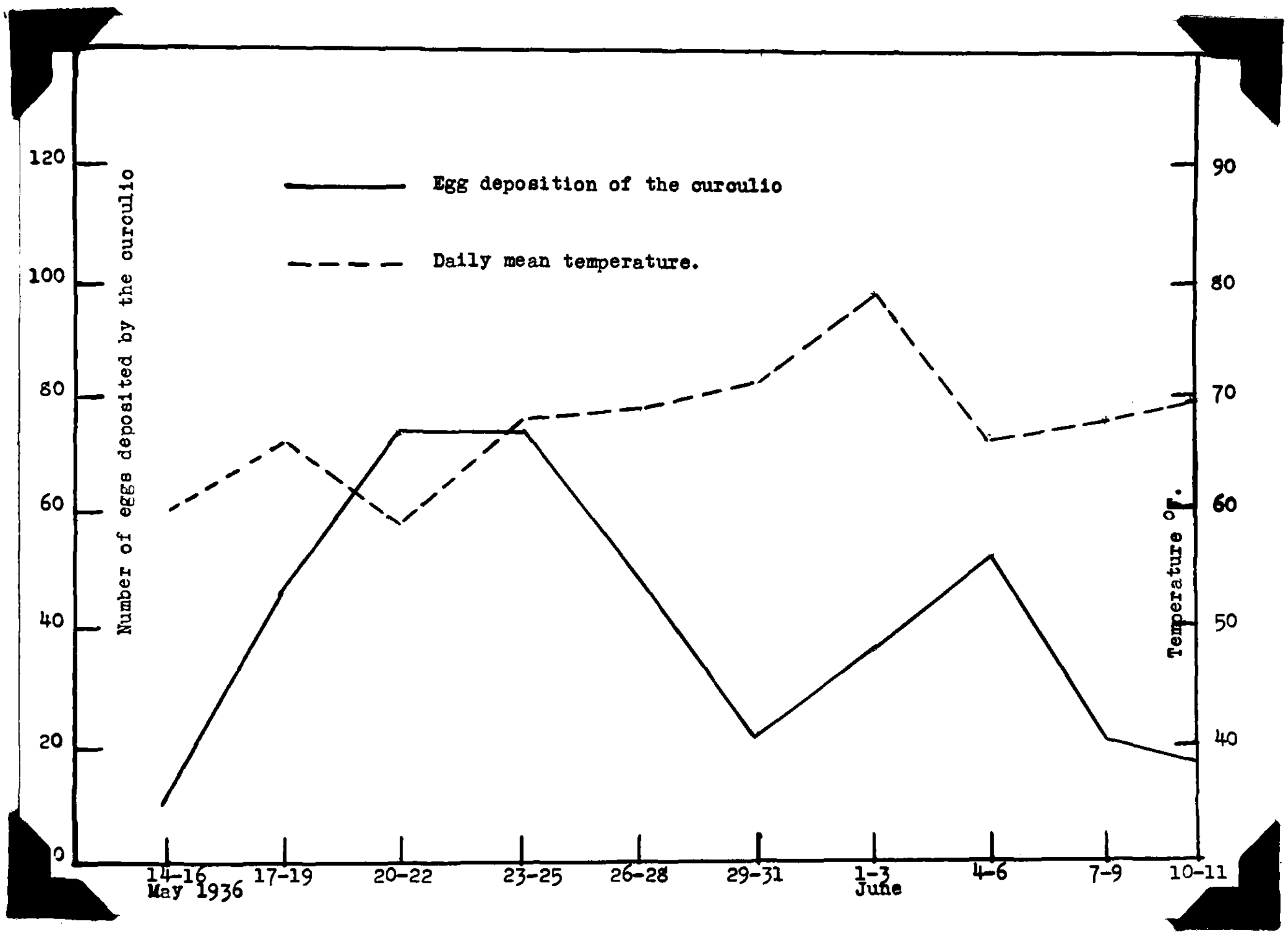
During 1936 the tests on the number of eggs deposited by the individual curculio were conducted in the same manner as in 1935. Ten beetles were used in these tests. Records were kept on the number of eggs deposited by each beetle over a period of 27 days. The minimum number of eggs deposited by an individual beetle was 17, the maximum number was 83, with an average of 40.5. The total number of eggs deposited by all 10 beetles was 405. These figures are shown in TABLE II and the relation of the number of eggs deposited to the daily mean temperature is shown in GRAPH XVI. The number of eggs deposited by an individual beetle in these tests is far below the number found by other investigators when the curculios were confined in larger containers than were used in the above tests.

GRAPH XV.



The relation between the egg deposition of the curculio and the daily mean temperature during 1935.

GRAPH XVI.



The relation between the egg deposition of the curculio and the daily mean temperature during 1936.

TABLE I.

Number eggs deposited by individual curculios in the insectary, Hancock, Md., 1935.

Curculio No.	Date / Temperature Daily Mean	May 15-17	18-20	21-23	24-26	27-29	June 30-1	2-4	5-7	8-10	11-13	14-16	17-19	Total No. Eggs deposited by each beetle
		52°	56°	55°	59°	66°	65°	66°	65°	60°	69°	74°	70°	
1		2	3	4	6	17	5	5	5	3	1	2	0	53
2		2	3	7	3	4	2	5	0	1	3	1	0	31
3		2	6	3	5	6	0	0	8	3	4	2	0	39
4		2	1	5	3	17	7	8	12	3	0	4	0	62
5		0	4	1	16	19	20	17	7	2	0	4	0	90
6		0	3	6	14	5	0	0	4	0	0	0	0	32
7		0	0	2	16	19	4	6	9	5	9	4	0	74
8		0	0	4	12	16	9	2	6	2	5	2	0	58
9		0	0	0	12	8	4	5	5	1	0	0	0	35
10		0	0	0	6	15	4	1	7	5	1	1	0	40
11		0	3	7	16	17	12	16	10	2	3	6	0	92
12		0	2	4	7	10	9	9	9	3	2	0	0	55
13		0	2	8	11	12	7	7	5	1	4	3	7	58
Total		8	27	51	127	165	83	73	87	31	32	27	7	720

Minimum number of eggs deposited by one female..........................34

Maximum number of eggs deposited by one female..........................92

Average number of eggs deposited by one female..........................55.3

TABLE II.

Number eggs deposited by individual curculios in the insectary, Hancock, Md., 1936

Curculio No.	Date	Eggs deposited during each 3 day period by each female: May 14-16	17-19	20-22	23-25	26-28	29-31	June 1-3	4-6	7-9	10-12	Total Number Eggs deposited by each beetle
	Temperature Daily Mean	60°	66°	59°	68°	69°	72°	79°	66°	68°	70°	
1		1	10	3	3	0	0	0	0	0	0	17
2		2	12	14	16	5	3	9	12	6	3	82
3		0	5	13	14	8	7	0	8	3	5	63
4		5	1	11	5	5	2	3	2	1	2	37
5		4	7	6	8	7	2	5	12	2	0	53
6		0	3	6	4	2	1	2	2	2	0	22
7		1	5	11	9	12	3	8	10	5	4	68
8		0	0	0	6	3	1	3	0	0	2	15
9		0	0	0	4	6	2	7	6	2	2	29
10		1	3	10	5	0	0	0	0	0	0	19
Total		11	46	74	74	48	21	37	52	21	18	405

Minimum number of eggs deposited by one female....................17
Maximum number of eggs deposited by one female....................82
Average number of eggs deposited by one female....................40.5

INCUBATION PERIOD OF THE CURCULIO EGG

In 1930 and 1931 tests were conducted to determine the incubation period of the curculio egg. The eggs used in these tests were obtained by placing fresh apples each day in a cage with the curculios. The apples were removed each day and the eggs removed and placed on a piece of flower pot that had been soaking in water for several days. The piece of pot containing the eggs was placed on a wad of wet cotton and a lantern globe placed over this. The cotton was thoroughly wetted each day to keep the eggs from becoming too dry.

Observations were made each day on the hatching of eggs at different intervals from May 8 until June 18, and the incubation period was recorded.

The data obtained in 1930 indicate that in general the length of the incubation period of the egg varies inversely with the daily mean temperature.

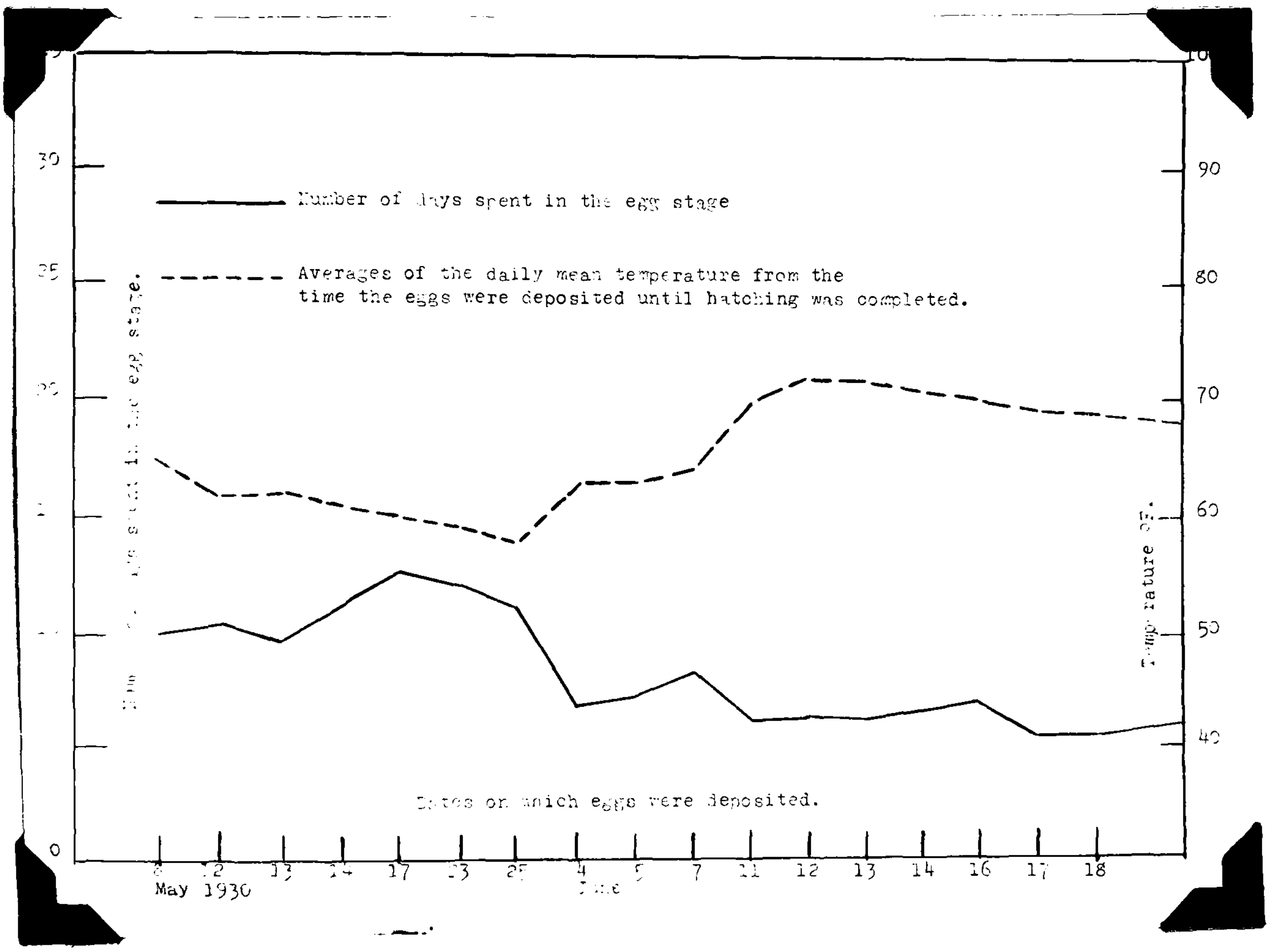
During May the averages of the daily mean temperature from the time the eggs were deposited until hatching was complete varied from 58° to 65° with eggs deposited on different dates. The length of the incubation period of the eggs varied from 10 days to 12 1/2 days.

During June the averages of the daily mean temperature from the time the eggs were deposited until hatching was complete varied from 63° to 72° with eggs deposited on different dates. The length of the incubation period of the egg varied from 8 1/2 to 5 1/2 days. The details of the data are shown in TABLE III. The averages of the daily mean temperature and the incubation period of the egg are shown in GRAPH XVII.

In 1931 records on the incubation period of the curculio egg was kept on eggs deposited at different intervals from May 5 until May 21. The data obtained show that the averages of the daily mean temperature from the date the eggs were deposited until hatching was complete varied from 58° to 59° with eggs deposited on different dates. The length of the incubation period of the eggs varied from 9 to 14 days.

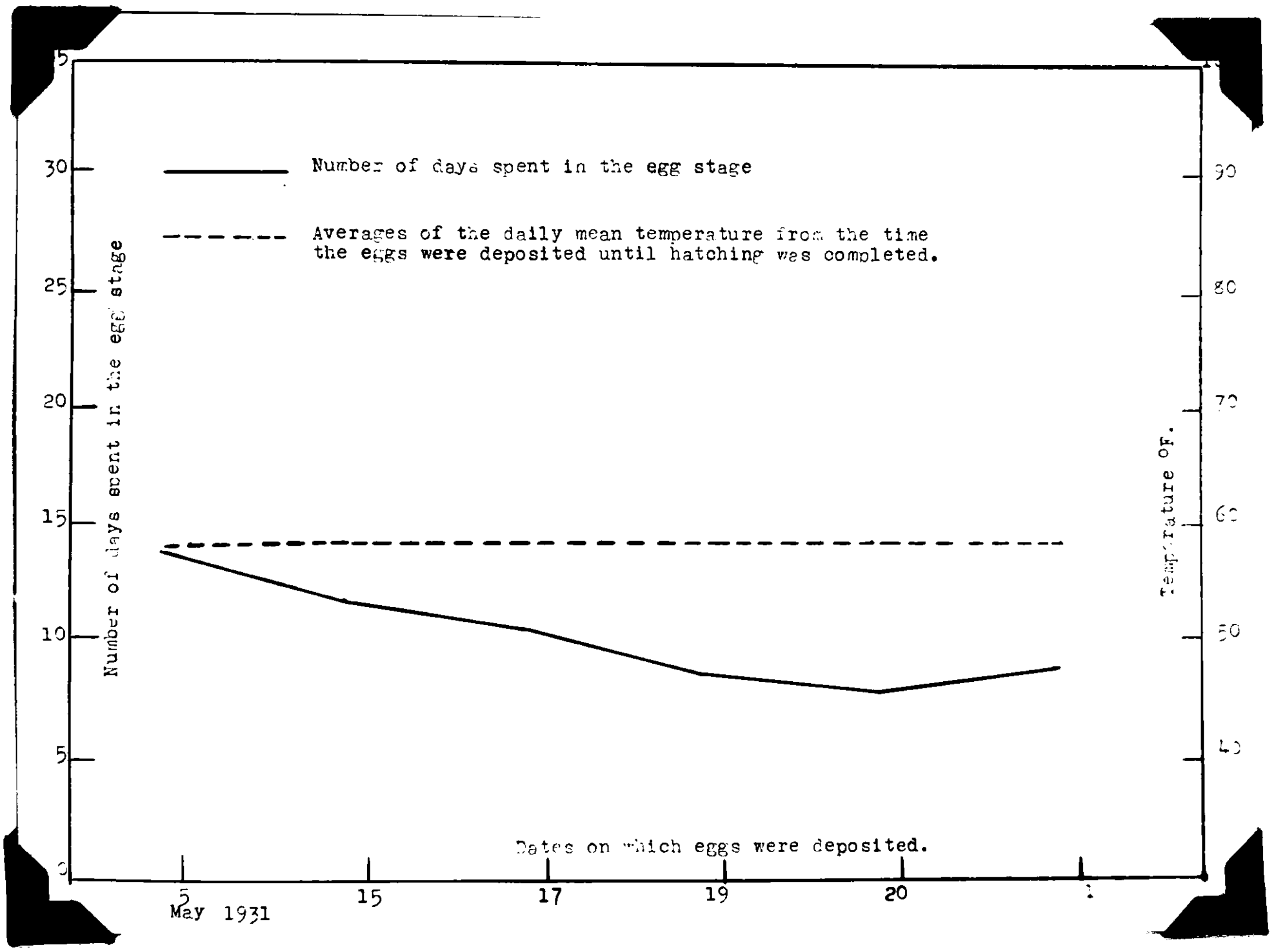
These results are not in accord with the results obtained in 1930, for even though the averages of the daily mean temperature from the time the eggs were deposited until hatching was complete remained practically constant, the incubation period of the eggs dropped from 14 days on May 5 to 9 days on May 21. There is no plausible explanation for the decrease in the incubation period of the egg, with the averages of the daily mean temperature remaining practically constant throughout the period that the records were kept. The data are shown in detail in TABLE IV. The averages of the daily mean temperature and the incubation period of the eggs are shown in GRAPH XVIII.

GRAPH XVII.



The relation between the incubation period of curculio eggs and the daily mean temperature during 1930.

GRAPH XVIII.



The relation between the incubation period of curculio eggs and the daily mean temperature during 1931.

TABLE III

Showing the relation between the daily mean temperature and the hatching of curculio eggs during 1930.

Date eggs deposited	No. eggs in test												
		Daily Mean temperature	74	69	68	61	62	65	65	59	58	61	61
		No. days from egg dep. until eggs hatched	May 8	9	10	11	12	13	14	15	16	17	18
May 8	25	Date & No. of eggs hatching											9

Average incubation period of eggs.......................................11 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched....64°, until hatching was complete 65°.

Date eggs deposited	No. eggs in test												
		Daily Mean temperature	62	65	65	59	58	61	61	66	61	58	70
May 12	35	No. days from egg dep. until eggs hatched	May 12	13	14	15	16	17	18	19	20	21	22
		Date & No. of eggs hatching										8	14

Average incubation period of eggs.................................... 10.6 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..62°, until hatching was complete 62°.

Date eggs deposited	No. eggs in test											
		Daily Mean temperature	65	65	59	58	61	61	66	61	58	70
May 13	30	No. days from egg dep. until eggs hatched	May 13	14	15	16	17	18	19	20	21	22
		Date & No. of eggs hatching										14

Average incubation period of eggs.................................... 10 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..62°, until hatching was complete 62°.

TABLE III. (continued)

Showing the relation between the daily mean temperature and the hatching of curculio eggs during 1930.

Date eggs deposited	No. eggs in test														
		Daily Mean temperature	65	59	58	61	61	66	61	58	70	71	62	51	53
May 14	35	No. days from egg dep. until eggs hatched	May 14	15	16	17	18	19	20	21	22	23	24	25	26
		Date & No. of eggs hatching										11	2	4	6

Average incubation period of eggs.................................. 11.2 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..63°, until hatching was complete 61°.

Date eggs deposited	No. eggs in test														
		Daily Mean temperature	59	58	61	61	66	61	58	70	71	62	51	53	52
May 15	23	No. days from egg dep. until eggs hatched	May 15	16	17	18	19	20	21	22	23	24	25	26	27
		Date & No. of eggs hatching												10	8

Average incubation period of eggs.................................. 12.4 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched....61°, until hatching was complet 60°.

TABLE III (continued)

Showing the relation between the daily mean temperature and the hatching of curculio eggs during 1930

Date eggs deposited	No. eggs in test		May 23	24	25	26	27	28	29	30	31	June 1	2	3	4	5
		Daily Mean temperature	71	62	51	53	52	64	56	47	47	55	66	69	70	63
May 23	30	No. days from egg dep. until eggs hatched														
		Date & No. of eggs hatching											2	16		1

Average incubation period of eggs.................................... 12 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..57°, until hatching was complete 59°.

Date eggs deposited	No. eggs in test		May 25	26	27	28	29	30	31	1	2	3	4	5
		Daily Mean temperature	51	53	52	64	56	47	47	55	66	69	70	63
May 25	25	No. days from egg dep. until eggs hatched												
		Date & No. of eggs hatching										3	17	7

Average incubation period of eggs.................................... 11.1 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..64°, until hatching was complete 58°.

TABLE III (continued)

Showing the relation between the daily mean temperature and the hatching of curculio eggs during 1930.

Date eggs deposited	No. eggs in test									
		Daily Mean temperature	70	64	68	64	60	60	63	60
June 4	40	No. days from egg dep. until eggs hatched	June 4	5	6	7	8	9	10	11
		Date & No. of eggs hatching						9	11	9

Average incubation period of eggs.................................... 7 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..63°, until hatching was complete 63°.

Date eggs deposited	No. eggs in test							
		Daily Mean temperature	64	68	64	60	60	63
June 5	10	No. days from egg dep. until eggs hatched	June 5	6	7	8	9	10
		Date & No. of eggs hatching						7

Average incubation period of eggs.................................... 7 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..63°, until hatching was complete 63°.

TABLE III (continued)

Showing the relation between the daily mean temperature and the hatching of curculio eggs during 1930.

Date eggs deposited	No. eggs in test										
		Daily Mean temperature	64	60	60	63	60	66	73	72	76
June 7	30	No. days from egg dep. until eggs hatched	June 7	8	9	10	11	12	13	14	15
		Date & No. of eggs hatching								15	11

Average incubation period of eggs.................................. 8.4 days

Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..64°, until hatching was complete 64°.

Date eggs deposited	No. eggs in test							
		Daily Mean temperature	60	66	75	72	76	72
June 11	20	No. days from egg dep. until eggs hatched	June 11	12	13	14	15	16
		Date & No. of eggs hatching						

Average incubation period of eggs.................................. 6 days

Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..69°, until hatching was complete 70°.

TABLE III. (continued)

Showing the relation between the daily mean temperature and the hatching of curculio eggs during 1930.

Date eggs deposited	No. eggs in test	Daily Mean temperature	66	73	72	76	72	72
June 12	17	No. days from egg dep. until eggs hatched	June 12	13	14	15	16	17
		Date & No. of eggs hatching						14

Average incubation period of eggs.................................. 6 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..72°, until hatching was complete 72°.

Date eggs Deposited	No. eggs in test	Daily Mean temperature	73	72	76	72	72	72
June 13	20	No. days from egg dep. until eggs hatched	June 13	14	15	16	17	18
		Date & No. of eggs hatching					8	9

Average incubation period of eggs.................................. 5.9 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..73°, until hatching was complete 72°.

TABLE III. (continued)

Showing the relation between the daily mean temperature and the hatching of curculio eggs during 1930.

Date eggs deposited	No. eggs in test								
		Daily Mean temperature	72	76	72	72	72	68	68
June 14	36	No. days from egg dep. until eggs hatched	June 14	15	16	17	18	19	20
		Date & No. of eggs hatching						27	6

Average incubation period of eggs.................................. 6.2 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..72°, until hatching was complete 71°.

Date eggs deposited	No. eggs in test								
		Daily Mean temperature	72	72	72	68	68	69	69
June 16	40	No. days from egg dep. until eggs hatched	June 16	17	18	19	20	21	22
		Date & No. of eggs hatching				10	7	11	6

Average incubation period of eggs................................ 6.3 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..71°, until hatching was complete 70°.

TABLE III. (continued)

Showing the relation between the daily mean temperature and the hatching of curculio eggs during 1930

Date eggs deposited	No. eggs in test							
		Daily Mean temperature	72	72	68	68	69	69
June 17	50	No. days from egg dep. until eggs hatched	June 17	18	19	20	21	22
		Date & No. of eggs hatching					25	19

Average incubation period of eggs.............................. 5.4 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..69°, until hatching was complete 69°.

Date eggs deposited	No. eggs in test							
		Daily Mean temperature	72	68	68	69	69	69
June 18	20	No. days from egg dep. until eggs hatched	June 18	19	20	21	22	23
		Date & No. of eggs hatching					7	11

Average incubation period of eggs................................ 5.6 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..69°, until hatching was complete 69°.

TABLE IV.

Showing the relation between the daily mean temperature and the hatching of curculio eggs during 1931.

Date eggs deposited	No. eggs in test																		
		Daily Mean temperature	56	60	61	56	49	48	52	61	69	59	58	65	65	60	54	47
May 9	15	No. days from egg dep. until eggs hatched	May 9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
		Date & No. of eggs hatching											1			5		3

Average incubation period of eggs.................................. 14.3 days

Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..57°, until hatching was complete 58°.

Date eggs deposited	No. eggs in test																
		Daily Mean temperature	52	61	61	59	58	65	65	60	54	48	51	57	62	66
May 15	24	No. days from egg dep. until eggs hatched	May 15	16	17	18	19	20	21	22	23	24	25	26	27	28
		Date & No. of eggs hatching											5	5	9	1

Average incubation period of eggs................................. 12.3 days

Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..58°, until hatching was complete 59°.

TABLE IV (continued)

Showing the relation between the daily mean temperature and the hatching of curculio eggs during 1931.

Date eggs deposited	No. eggs in test													
		Daily Mean temperature	69	59	58	65	65	60	54	47	51	57	62	66
May 17	25	No. days from egg dep. until eggs hatched	May 17	18	19	20	21	22	23	24	25	26	27	28
		Date & No. of eggs hatching										4	12	9

Average incubation period of eggs.................................... 11.2 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..58°, until hatching was complete 59°.

Date eggs deposited	No. eggs in test												
		Daily Mean temperature	58	65	65	60	54	47	51	57	62	66	68
May 19	20	No. days from egg dep. until eggs hatched	May 19	20	21	22	23	24	25	26	27	28	29
		Date & No. of eggs hatching									14	3	1

Average incubation period of eggs................................. 9.3 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..57°, until hatching was complete 59°.

TABLE IV. (continued)

Showing the relation between the daily mean temperature and the hatching of curculio eggs during 1931.

Date eggs deposited	No. eggs in test											
		Daily Mean temperature	65	65	60	54	47	51	57	62	66	68
May 20	30	No. days from egg dep. until eggs hatched	May 20	21	22	23	24	25	26	27	28	29
		Date & No. of eggs hatching								11	9	10

Average incubation period of eggs.................................... 8.9 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..57°, until hatching was complete 59°.

Date eggs deposited	No. eggs in test												
		Daily Mean temperature	65	60	54	47	51	57	59	62	64	66	65
May 21	25	No. days from egg dep. until eggs hatched	May 21	22	23	24	25	26	27	28	29	30	31
		Date & No. of eggs hatching								5	9	7	4

Average incubation period of eggs.................................... 9.4 days
Averages of the daily mean temperature from the time the eggs were deposited until the first eggs hatched..57°, until hatching was complete 59°.

LENGTH OF EGG AND LARVAE STAGES IN FRUIT 1931

Data on the length of the egg stage and feeding period of the larvae of the plum curculio were obtained by placing small peaches in battery jars containing several female curculios and leaving the peaches there for one day. The peaches were then removed and transferred to a wire tray suspended in a battery jar. Upon leaving the peaches, the larvae would drop to the bottom of the jar, from which they were removed each day.

The data shows that the first larvae left the fruit in 21 days, and that a few remained in the fruit for 29 days. The average number of days spent in fruit was 24.09 days. The data are shown in TABLE V.

TABLE V.

Length of time spent in fruit by the curculio eggs and larvae, 1931.

Date eggs deposited	Number eggs deposited	Date larvae left fruit	June 16	17	18	19	20	21	22	23	24
May 26	75	No. larvae left fruit	2	11	6	15	8	4	3	1	2

Minimum number of egg and larva days spent in fruit... 21
Maximum number of egg and larva days spent in fruit... 29
Average number of egg and larva days spent in fruit... 24.09

LENGTH OF THE LARVAL AND PUPAL STAGES IN SOIL

The data presented on the length of the larval and pupal stages of the plum curculio in soil were obtained by taking shell vials and lantern globes, packing them full of dirt, and taking a small wire and making an opening in the soil by pushing the wire into the soil in contact with the glass. After the wire was removed the larvae were inserted into the hole, and the containers wrapped with dark cloth or embedded in the soil to exclude the sunlight. By excluding the sunlight many larvae would form their cells against the glass where observations on the length of the stages could easily be made. The data obtained are shown in TABLE VI.

TABLE VI.

Length of time spent in soil by curculio larvae before pupating, Hancock, Md., 1936.

Larva left fruit	No. of larvae transforming to pupa in a definite No. of days after the larva entered the soil													Total No. larvae transforming to pupa	Average No. days spent in larvae
	8	9	10	11	12	13	14	15	16	17	18	19	20		
June 16			1	1	1	0	2	3	1	0	1	0	1	11	14.55
June 20		1	0	1	2	1	0	1	0	2	0	1		9	13.90
June 22	2	3	0	0	4	1	0	2	0	1	0	1		13	12.10
July 1	3	2	1	0	0	2	1	1	0	0	1			11	9.54

Minimum number of days spent as larva in soil.................... 9
Maximum number of days spent as larva in soil....................20
Average number of days spent as larva in soil....................12.52

TABLE VI (continued)

Length of the pupae stage of the curculio, Hancock, Md., 1936

Larva left fruit	Number of pupa transforming into adults in a specified number of days									Total No. transforming to adults	Average No. days spent as pupa
	7	8	9	10	11	12	13	14	15		
June 16		1	2	2	1	2	2	0	1	11	11.1
June 20			1	3	2	0	1	1	0	8	11
June 22	1	3	2	0	1	2	0	1	1	11	11.1
July 1	2	1	3	0	2	1	0	1	0	10	9.70

Minimum number of days spent in soil as pupa.................... 7
Maximum number of days spent in soil as pupa....................15
Average number of days spent in soil as pupa....................10.72

LENGTH OF TIME SPENT IN SOIL BY THE LARVAE PUPAE AND ADULTS OF THE CURCULIO

In 1930, 1931, 1932 and 1936, tests were conducted to determine the length of time spent in the soil by all stages of the curculio. The information was obtained by burying 12 inch flower pots or lantern globes in the soil so that about 1 inch of the tops protruded above the level of the soil. The pots or globes were then filled with soil to within 1 inch of the top. A known number of larvae were placed in the containers and a piece of cheese cloth was placed over the top and held in place by a rubber band to prevent the curculios from escaping after they had emerged. Data were kept on the dates and number of curculio emerging from each pot.

In 1930, 1,105 larvae were used in the tests. The records show that the maximum number of days spent in the soil by the different stages of the curculio was 43, the minimum number 27, with an average of 33.66. The percentage of larvae to emerge as adults was 29.

TABLE VII shows the number of beetles emerging in a specific number of days after the larvae entered the soil.

In 1931 90 larvae were used in the tests. The records show that the maximum period spent in the soil was 40 days, the minimum period 26, with an average of 33.25 days. The percentage of larvae to emerge as adults was 24.4. The data are shown in TABLE VIII.

In 1932 2,980 larvae were used in the tests. The records show that the maximum period spent in soil was 60 days, the minimum 29 days, with an average of 39.5 days. The percentage of larvae to emerge as adults was 46.80.

The date and number of larvae entering the pots and the dates on which the adults emerged are shown in TABLE IX.

In 1936 400 larvae were used in the tests. The maximum number of days spent in the soil was 43, the minimum was 33, with an average of 38.8. The percentage of larvae to emerge as adults was 75.25.

The dates and number of larvae entering the lantern globes and the dates and number of adults emerging are shown in TABLE X.

The averages of the maximum number of days spent in soil by curculio larvae, pupae and adults from all tests were 46.5. The averages of the minimum number of days spent in soil by curculio larvae, pupae and adults from all tests were 28.75.

The average number of days spent in soil by curculio larvae, pupae and adults was 36.30 for all tests.

TABLE VII.

Length of time spent in soil by curculio larvae pupa and adults, Hancock, Md., 1930

Date larvae entered soil	No. larvae entering soil	No. adult beetles emerging in a specified no. of days after the larvae entered soil 27	29	31	33	35	37	39	41	43	Total	Average No. days spent in soil
June 12	60					1	6	6	2	3	18	39.00
13	75				1	7	14	9	13		44	38.20
30	75	4	14	12	1						31	29.64
July 2	170				4	17	8	5	3		37	36.24
3	255		21	29	27	15	4	2			98	32.23
4	120	2	5	1							8	28.75
7	270	3	6	19	11	4	2	1	3	5	54	33.29
10	55		3	11	4						18	30.61
12	25		4			1		7	1		13	35.79
Total	1,105	9	53	72	48	45	34	30	22	8	321	33.66

Minimum number of days spent in soil........................27
Maximum number of days spent in soil........................43
Average number of days spent in soil........................33.66
Per cent of larvae to emerge as adults....................29.0

TABLE VIII.

Length of time spent in soil by larvae, pupae and adults of the curculio-1931

Date larvae entered soil	No. larvae entering soil	No. adults emerging in a specified number of days								Total Number adult to emerge
		26	28	30	32	34	36	38	40	
June 2	90	2	3	2	1	5	5	3	1	22

Minimum number of days spent in soil.................... 26
Maximum number of days spent in soil.................... 40
Average number of days spent in soil.................... 33.25
The per cent of larvae to emerge as adults.............. 24.4

TABLE IX.

Pot #1

Emergence of summer brood curculios from flower pots, Hancock, Md., 1932

No. larvae entering soil	Date larvae entered soil	Date adults emerged	July 17	18	19	20	21	22	23	24	25	26	27	28	29
110	June 12	No. adults emerged	2	1	2	2	3	2	1	0	0	0	0	0	1

Total number of adults to emerge............14
Minimum number of days spent in soil........35
Maximum number of days spent in soil........47
Average number of days spent in soil........38.64
Per cent of larvae to emerge as adults......12.7

Pot #2

Emergence of summer brood curculios from flower pots, Hancock, Md., 1932

No. larvae entering soil	Date larvae entered soil	Date adults emerged	July 17	18	19	20	21	22	23	24	25	26	27	28	29
110	June 13	No. adults emerged	2	0	5	3	15	14	5	1	0	0	1	1	0

Total nymber of adults to emerge............47
Minimum number of days spent in soil........34
Maximum number of days spent in soil........45
Average number of days spent in soil........38.83
Per cent of larvae to emerge as adults......47.72

Pot #3

Emergence of summer brood curculios from flower pots, Hancock, Md., 1932

No. larvae entering soil	Date larvae entered soil	Date adults emerged	July 18	19	20	21	22	23	24	25	26	27	28	29
75	June 14	No. adults emerged	3	8	3	8	12	6	1	0	0	2	0	0

Total number of adults to emerge............41
Minimum number of days spent in soil........34
Maximum number of days spent in soil........44
Average number of days spent in soil........38.83
Per cent of larvae to emerge as adults......54.66

TABLE IX. (continued)

Pots #4, #5, and #6

Emergence of summer brood curculios from flower pots, Hancock, Md., 1932

No. larvae entering soil	Date larvae entered soil	Date adults emerged	July 17	18	19	20	21	22	23	24	25	26	27	28	29	30
255	June 15	No. adults emerged	4	6	18	17	25	33	16	6	1	5	5	3	1	0

Total number of adults to emerge............140
Minimum number of days spent in soil........ 32
Maximum number of days spent in soil........ 44
Average number of days spent in soil........ 36.57
Per cent of larvae to emerge as adults...... 54.90

Pots #7, #8, and #9

Emergence of summer brood curculios from flower pots, Hancock, Md., 1932

No. larvae entering soil	Date larvae entered soil	Date adults emerged	July 17	18	19	20	21	22	23	24	25	26	27	28	29	30
300	June 16	No. adults emerged	16	14	36	32	56	20	7	4	1	0	10	1	0	1

Total number of adults to emerge............198
Minimum number of days spent in soil........ 31
Maximum number of days spent in soil........ 44
Average number of days spent in soil........ 34.56
Per cent of larvae to emerge as adults...... 66.00

Pots #10, #11, #12 and #13

Emergence of summer brood curculios from flower pots, Hancock, Md., 1932

No. larvae entering soil	Date larvae entered soil	Date adults emerged	July 19	20	21	22	23	24	25	26	27	28	29	30	31	August 1	2	3	4	5
400	June 17	No. adults emerged	12	16	18	26	19	9	5	16	21	10	5	0	6	2	3	4	0	1

Total number of adults to emerge............173
Minimum number of days spent in soil........ 32
Maximum number of days spent in soil........ 49
Average number of days spent in soil........ 37.39
Per cent of larvae to emerge as adults...... 43.25

TABLE IX. (continued)

Pots #14, #15, #16 and #17

Emergence of summer brood curculios from flower pots, Hancock, Md., 1932.

No. larvae entering soil	Date larvae entered soil	Date adults emerged	July 17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	August 1	2	3	4	5	6	7	8
		No. adults emerged																							
400	June 18		1	5	12	9	45	64	24	6	11	14	23	6	7	0	0	0	1	5	1	4	1	1	0

Total number of adults emerged............242
Minimum number of days spent in soil...... 29
Maximum number of days spent in soil...... 50
Average number of days spent in soil...... 35.42
Per cent of larvae to emerge as adults.... 60.50

Pots #18, #19, #20 and #21

Emergence of summer brood curculios from flower pots, Hancock, Md., 1932.

No. larvae entering soil	Date larvae entered soil	Date adults emerged	July 18	19	20	21	22	23	24	25	26	27	28	29	30	31	August 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		No. adults emerged																													
400	June 19		3	11	14	51	37	18	8	5	15	10	7	3	0	3	0	0	3	1	1	0	2	0	0	0	0	0	0	0	4

Total number of adults to emerge............196
Minimum number of days spent in soil........ 29
Maximum number of days spent in soil........ 60
Average number of days spent in soil........ 34.68
Per cent of larvae to emerge as adults...... 49.00

TABLE IX. (continued)
Pots #22, #23 and #24

Emergence of summer brood curculios from flower pots, Hancock, Md., 1932.

No. larvae entering soil	Date larvae entered soil	Date adults emerged	July 20	21	22	23	24	25	26	27	28	29	30	31	August 1	2	3	4	5	6	7	8
260	June 20	No. adults emerged	1	3	16	17	4	4	15	13	7	5	4	6	3	2	13	3	0	0	2	2

Total number of adults emerged...........120
Minimum number of days spent in soil...... 30
Maximum number of days spent in soil...... 49
Average number of days spent in soil...... 38.1
Per cent of larvae to emerge as adults.... 46.11
Per cent of larvae to emerge as adults
from all pots........................... 50.69

Emergence of summer brood curculios from flower pots, Hancock, Md., 1933.

Number larvae entering soil	Date larvae entered soil	Date adults emerged	No. adults emerging during ea 4 da. period July 11-14	15-18	19-22	23-26	27-30
700	June 9	No. adults emerged	11	63	44	59	45

Total number of adults to emerge...........223
Per cent of larvae to emerge as adults...... 31.85
Minimum number of days spent in soil........ 32.0
Maximum number of days spent in soil........ 40.0

TABLE X.

Globe No. 1

Emergence of summer brood curculio from lantern globes, Hancock, Md., 1936

No. larvae entering soil	Date larvae entered soil	Date adults emerged	July 24	25	26	27	28	29	30	31
50	June 16	No adults emerged	8	7	8	9	7	0	0	0

Total number of adults to emerge....................39
Minimum number of days spent in soil................38
Maximum number of days spent in soil................42
Average number of days spent in soil................41
Per cent of larvae to emerge as adults..............78

Globe No. 2

Emergence of summer brood curculio from lantern globes, Hancock, Md., 1936

No. larvae entering soil	Date larvae Entered soil	Date adults Emerged	July 24	25	26	27	28	29	30	31
50	June 17	No adults emerged	6	20	6	8	1	1	0	0

Total number of adults to emerge....................42
Minimum number of days spent in soil................38
Maximum number of days spent in soil................43
Average number of days spent in soil................39.5
Per cent of larvae to emerge as adults..............84

Globe No. 3

Emergence of summer brood curculio from lantern globes, Hancock, Md., 1936

No. larvae entering soil	Date larvae Entered soil	Date adults emerged	July 24	25	26	27	28	29	30	31
100	June 18	No adults emerged	4	53	10	14	0	1	0	0

Total number of adults to emerge....................82
Minimum number of days spent in soil................37
Maximum number of days spent in soil................42
Average number of days spent in soil................38.4
Per cent of larvae to emerge as adults..............82

TABLE X. (continued)

Globe No. 4

Emergence of summer brood curculio from lantern globes, Hancock, Md., 1936

No. larvae entering soil	Date larvae entered soil	Date adults emerged	July 24	25	26	27	28	29	30	31
50	June 19	No adults emerged	7	0	4	6	5	0	0	0

Total number of adults to emerge....................22
Minimum number of days spent in soil.................36
Maximum number of days spent in soil.................40
Average number of days spent in soil.................38.07
Per cent of larvae to emerge as adults...............44

Globe No. 5

Emergence of summer brood curculio from lantern globes, Hancock, Md., 1936

No. larvae entering soil	Date larvae entered soil	Date adults emerged	July 24	25	26	27	28	29	30	31
150	June 21	No adults emerged	14	18	34	29	9	7	5	0

Total number of adults to emerge....................116
Minimum number of days spent in soil................. 33
Maximum number of days spent in soil................. 39
Average number of days spent in soil................. 35.3
Per cent of larvae to emerge as adults............... 71.3

THE AVERAGE LENGTH OF TIME SPENT IN THE DIFFERENT STAGES FROM EGG TO ADULT CURCULIO

TABLE XI.
The average length of the different stages of the plum curculio

Length of egg stage	Length of larval stage in fruit	Length of larval stage in soil	Length of pupal stage	Length of adult stage in soil	**Total time spent in fruit and soil**
8.83	15.26	12.25	10.72	13.66	60.99

The average of 13.66 days spent in the soil by the adult curculio is much longer than the period of time reported by other investigators. This period of time, however, is dependent upon the precipitation previous to emergence. If the period of transformation from the pupal to the adult stage is preceded by a period of drought the adult curculio, even though fully developed, will remain in the soil until a rain wets the soil. This period may be only a few days or several weeks. Therefore, the length of time spent in the soil by the adult curculio is dependent entirely upon the precipitation during this period and not upon the time of maturity of the curculio.

THE PERIOD OF EMERGENCE OF CURCULIO LARVAE FROM FRUIT DROPS AND THE PERIOD OF EMERGENCE OF ADULT CURCULIO FROM THE SOIL FROM 1928 to 1936

Records on the dates that curculio larvae began to leave fruit drops to enter the soil, and the period over which they leave these drops, are necessary in setting up control measures. The practice of picking the small peaches that drop to the ground in early spring is followed in many heavily infested orchards. If this practice is carried out to the best advantage the small fruits must be picked up before the larvae reach maturity and enter the soil. In order to get records on this phase of the larval activity small fruits were picked up in orchards from 1930 to 1936, presumably before any larvae had left them.

After the drops were picked up they were carried to the laboratory and placed in a tray with the bottom covered with 1/4 inch mesh wire. The tray was 2 1/2 feet wide and 6 feet long, and was held off the ground by four legs similar to a table. A piece of cloth was stretched beneath the wire for the purpose of catching the larvae as they left the small fruits and dropped through the wire. A damp piece of gunny sack was placed on the cloth to prevent the larvae from drying out when they dropped through on the cloth. The period over which the larvae left the fruit, and the relation of precipitation and the daily mean temperature upon their leaving the fruit are shown in GRAPHS XX to XXVI respectively.

Records on the period of time spent in the soil by the curculio, and the period over which emergence of the adult takes place, is necessary in applying supplementary control methods. This information was obtained by taking the larvae as they left the peach drops and transferring them to a bottomless screen wire cage buried about 8 inches in the soil. Records on the date and number of curculio emerged were kept. If soils which contain curculio pupae are cultivated many of the pupal cells are broken open and the pupa are unable to form another cell will die. Also many of larvae and pupa will be crushed or exposed to birds or the hot sun and die. Therefore, records showing the dates on which the greatest number of pupae are in the soil at any one time are valuable in making recommendations for control by cultivation. Data on the dates that the summer brood curculios began to leave the soil furnish valuable information on this point.

Eight year records on the emergence of the summer brood of the curculio from the soil, and the relation of precipitation and the daily mean temperature to the time and number of adults to emerge, are shown in GRAPHS XIX to XXVI respectively.

In 1929 about two bushels of peach drops, from 1/4 to 1/2 inches in diameter, were picked up and placed in a screen wire cage 4 feet square. About 12 inches of soil was placed on the bottom of the cage and a tray made out of 1/4 inch mesh wire was built about 6 inches above the dirt. The peaches were put in the tray and as the larvae left the peaches they dropped through the screen into the soil. No. records were kept on the number of larvae leaving the drops.

The adult curculio began to emerge from the soil on July 14. The peak of emergence occurred between July 25 and 29. A total of 1,147 adults emerged from the cage. The emergence of the curculio in relation to the precipitation and daily mean temperature is shown in GRAPH XIX.

In 1930 tests were started to determine the length of the period that curculio larvae leave fruit drops to enter the soil. Accordingly about three bushels of peach drops were picked up on June 7 and placed in the tray previously described.

The larvae began to leave the fruit on June 8 and continued to emerge until June 27, at which time observations were discontinued. A total of 2,322 larvae emerged during the observation period. The peak of emergence occurred between June 13 and 16, with a gradual falling off each day until observations were discontinued. The figures show that 81.18% of the larvae emerged in the first 10 days after the drops were picked up, with the remaining 18.81% emerging during the next 10 days. The emergence of the larvae in relation to precipitation and daily mean temperature is shown in GRAPH XX.

Each year the larvae that emerged from the drops were transferred to a screen wire cage and records kept on the date and number of adults emerging.

The adults in 1930 began to emerge on July 14, or 36 days after the first larvae were placed in the cage, and continued until August 12. The peak of emergence was reached between July 22 and 26. The total number of adults to emerge was 1,083, or 45.48% of the number of larvae placed in the cage. The emergence of the adults in relation to the precipitation and daily mean temperature is also shown in GRAPH XX.

In 1931 peach and Transparent apple drops were placed in the tray and records kept on the emergence of the larvae. The larvae began to emerge on June 14, and continued until July 9. A total of 1,485 larvae emerged. The peak was reached on June 21. 49.4% of the larvae left the fruit during the first 10 days after emergence started, with the remaining 50.60% leaving within the next 14 days. The emergence of the larvae in relation to the precipitation and daily mean temperature is shown in GRAPH XXI.

In 1931 adults began to emerge on July 17, or 33 days after the first larvae were placed in the cage, and continued until August 9. The peak was reached between July 23 and 25. The total number of adults to emerge was 194, or 13.06% of the number of larvae placed in the cage. The emergence of the adult curculio in relation to precipitation is also shown in

GRAPH XXI.

In 1932 the emergence of the curculio larvae from Transparent apple drops started on June 12 and continued until July 14. A total of 5,676 larvae emerged from the apple drops. The peak of emergence was reached between June 18 and 24. 88.23% of the larvae left the fruit during the first 10 days after the drops were placed in the tray, with 8.74% leaving in the next 12 days. The emergence of larvae in relation to precipitation and the daily mean temperature is shown in GRAPH XXII.

In 1932 the adult curculio began to emerge from the soil on July 13, or 29 days after the first larvae entered the soil, and continued to emerge until August 10. The peak of emergence was reached on July 21. The total number of adults to emerge was 1,786, or 31.5% of the larvae placed in the cage. The emergence of the adults in relation to precipitation and daily mean temperature is also shown in GRAPH XXII.

In 1933 the curculio larvae began to leave the peach drops on June 6 and continued to emerge until June 30. A total of 2,587 emerged from the peach drops. The peak of emergence was reached between June 6 and 10, with 84.23% emerging in the first 10 days after the peaches were placed in the tray, and the remaining 15.77% emerging during the next 15 days. The emergence of the larvae in relation to the precipitation and daily mean temperature is shown in GRAPH XXIII.

The emergence of curculios from the above mentioned larvae began on July 11, or 35 days after the first larvae were placed in the cages. The peak of emergence was reached between July 24 and 27. A total number of adults to emerge was 313, or 12.05% of the larvae placed in the cage. The emergence of the adults in relation to the precipitation is also shown in GRAPH XXIII.

In 1934 the curculio larvae began to leave the Transparent apple drops on June 12 and continued to emerge until July 1. A total of 6,196 larvae emerged from the apples. The peak was reached between June 20 and 24, with a gradual falling off until emergence ceased. 61.08% of the larvae emerged during the first 10 days after the apples were placed in the tray, and the remaining 38.92% emerged during the next 10 days. The emergence of the larvae in relation to the precipitation and daily mean temperature is shown in GRAPH XXIV.

The above mentioned larvae began to emerge as adults on July 10 and continued until July 4. The total number of adults to emerge was 1,102 with the first adult emerging 28 days after the first larvae were placed in the cage. The peak of emergence occurred between July 21 and 24. The percentage of the larvae placed in the cage to emerge as adults was 17.78. The emergence of the larvae in relation to the precipitation is shown in GRAPH XXIV.

In 1935 curculio larvae began to leave Transparent apple drops on June 14, and continued to emerge until July 9. A total of 1,650 larvae emerged from the drops. The peak was reached between June 17 and 20. 65.81% emerged during the first 10 days with the remaining 34.19% emerging during the next 10 days. The emergence of the larvae in relation to the precipitation and daily mean temperature is shown in GRAPH XXV.

The first adults from the above mentioned larvae began to emerge on July 22, and continued to emerge until August 1. The total number of adults to emerge was 94, with the first curculio emerging on the 38th day after the first larvae were placed in the cage. The peak of emergence occurred on July 29. The percentage of larvae placed in the cage to emerge as adults was 5.76. The emergence of the adults in relation to the precipitation and daily mean temperature is also shown in GRAPH XXV.

In 1936 curculio larvae began to leave peach drops on June 11 and continued to emerge until July 10. A total of 3,871 larvae emerged from the drops. The peak of emergence was reached between June 11 and 14. 82% of the larvae emerged during the first 10 days with the remaining 18% emerging during the next 15 days. The emergence of the larvae in relation to the daily mean temperature is shown in GRAPH XXVI.

The adults from the above larvae began to emerge on July 24 and continued until August 3. The total number of adults was 1,129, with the first adult emerging 43 days after the first larvae were placed in the cage. The peak of emergence occurred on July 25, or 1 day after emergence started. The percentage of larvae placed in the cage to emerge as adults was 28.8. The emergence of adults in relation to precipitation and daily mean temperature is also shown in GRAPH XXVI.

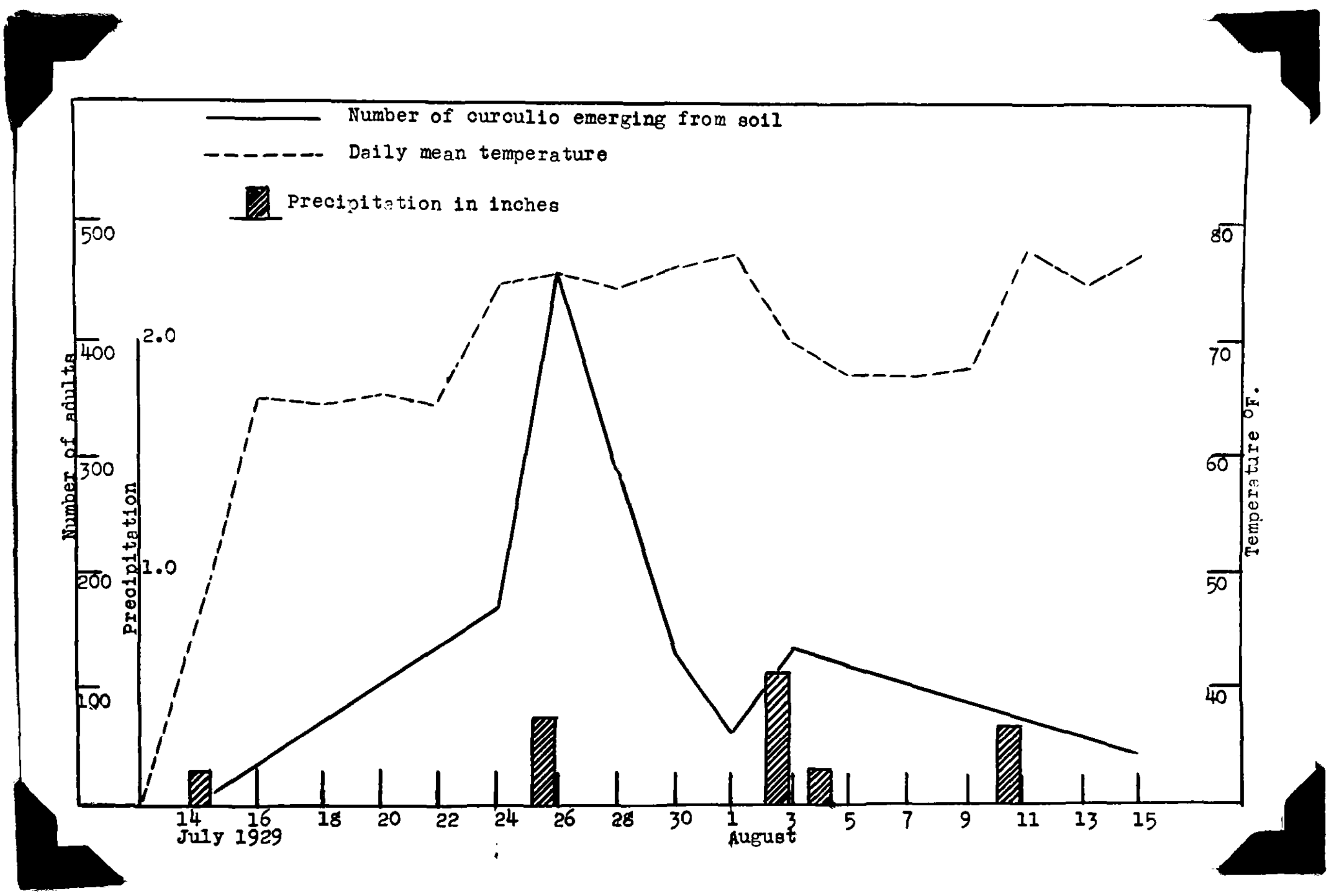
After analyzing the data obtained on the emergence of larvae from fruit drops it is obvious that there is a direct relationship between precipitation and the date and number of larvae and adults to emerge. This relationship is shown most clearly when a dry spell precedes the period when emergence would normally start. In such instances the emergence of the larvae or adults is retarded until a wetting rain, and then the emergence shows a very abrupt rise. However, if during the period the larvae are in the drops, and during the period the adult curculios are in the soil, rains occur often enough to keep the drops soft, and if the soil is wet throughout the emergence period of both larvae and adults, there will be no sharp peak such as occurs when rain follows a dry spell.

There is apparently no significant relationship between daily mean temperature and the emergence of larvae from drops and the emergence of adults from the soil. The ranges in the temperature during the period of emergence is not great enough to affect the activity of the larvae or adults during this period.

Studies were made to determine what effect precipitation has on the percentage of larvae entering the soil to emerge as adults. It has been observed by the writer that in years when the precipitation was heavy during the period spent in the soil by the different stages of the curculio, that the percentage of the larvae to emerge as adults was extremely low,. Upon examination of the soil, dead larvae, pupae and adults could be found covered with a white mold. In seasons when the rainfall was light during the time the different stages were in the soil the percentage of adults to emerge was heavy.

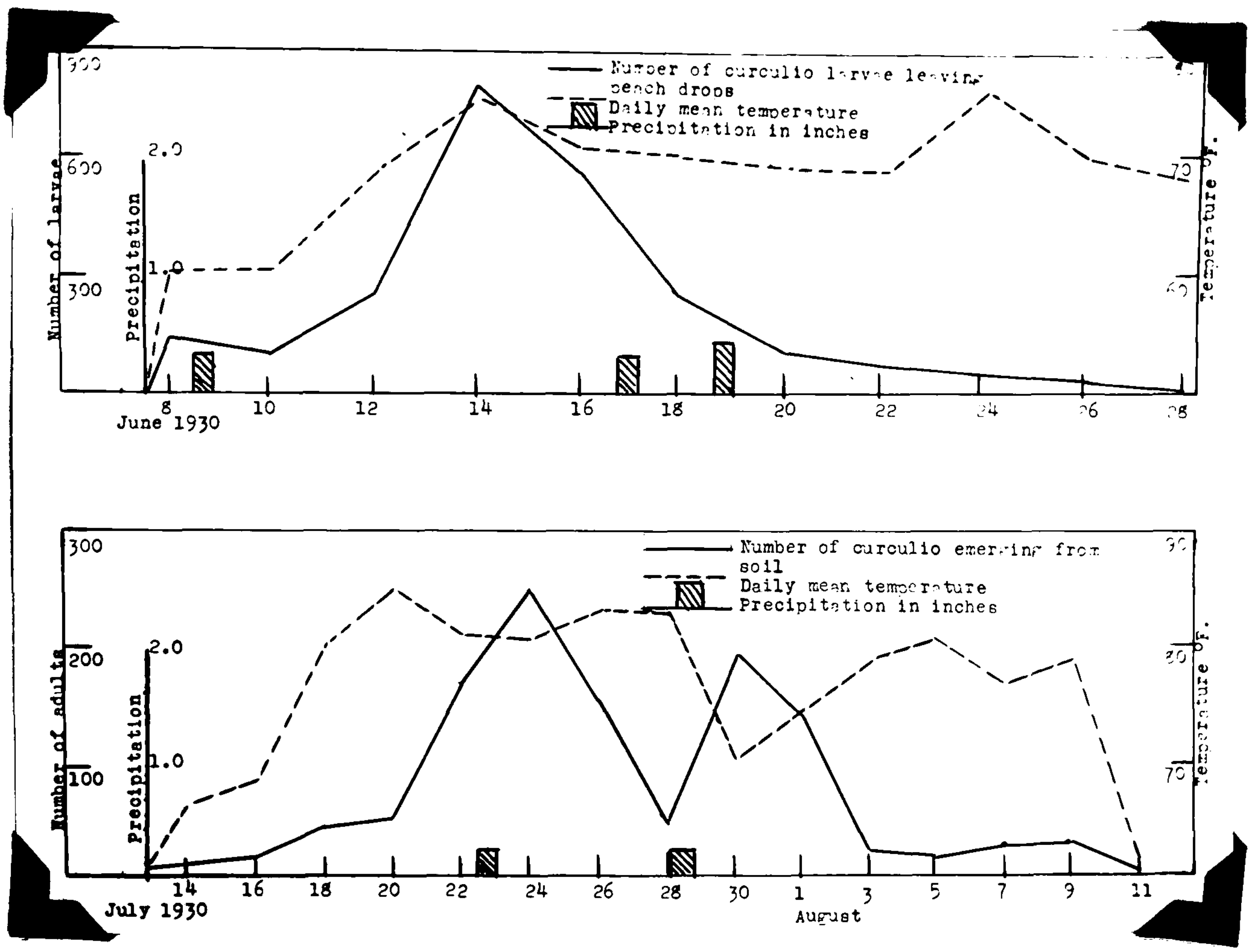
In 1936 the rainfall and the percentage of adults to emerge were both heavy, but this is explained by the fact that there was practically no precipitation in July until the 24th, at which time practically all the curculios were matured and ready to emerge. Therefore, after the rain on July 24, the curculios began to emerge in large numbers, reaching the peak on July 25. 6.46 inches of rain fell from July 24 to 29. The total precipitation from the time the larvae entered the soil until all adults had emerged, and the percentage of larvae that entered the soil to emerge as adults is shown in GRAPH XXVII.

GRAPH XIX.



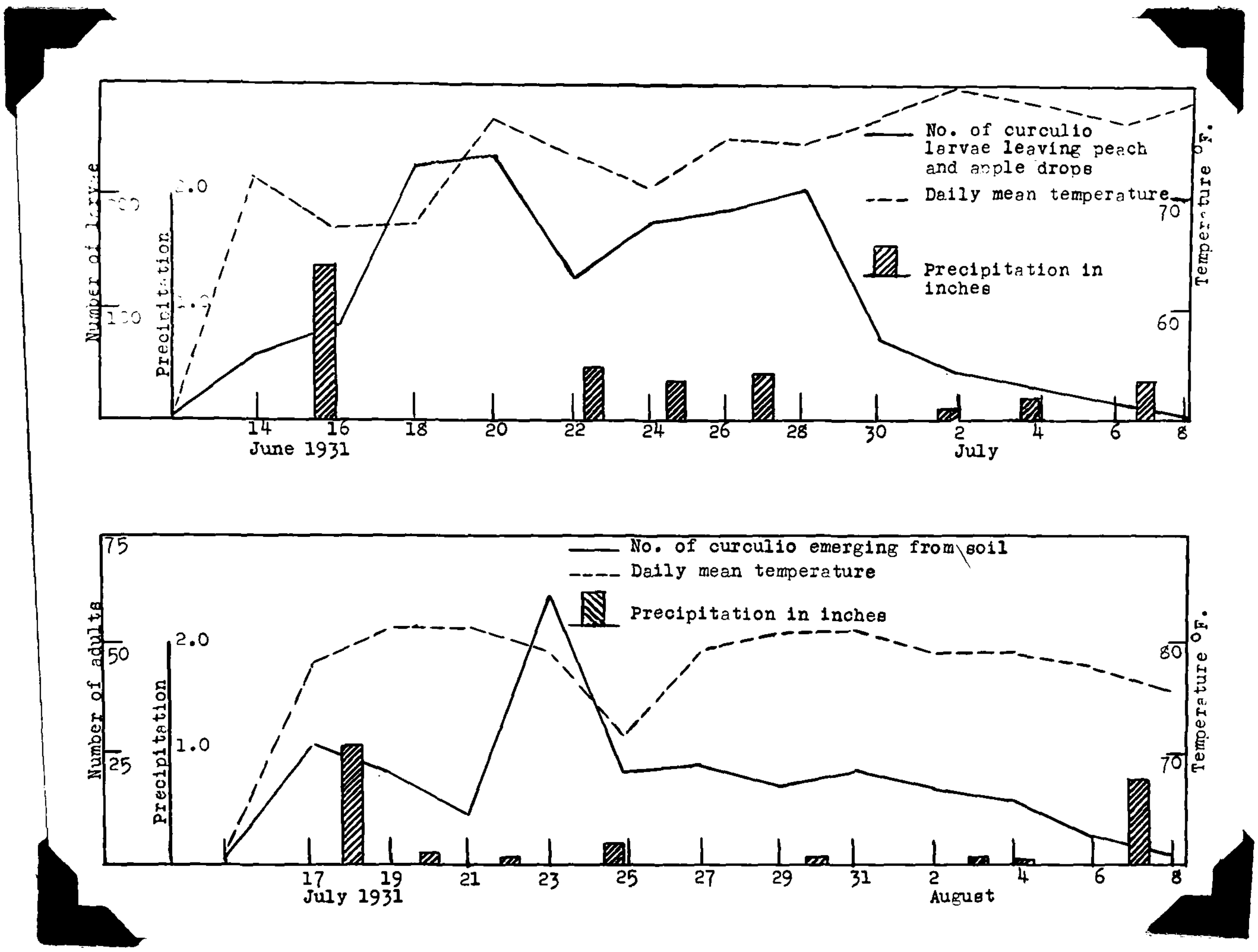
The relation of the emergence of the summer brood curculio to the daily mean temperature and the precipitation during 1929.

GRAPH XX.



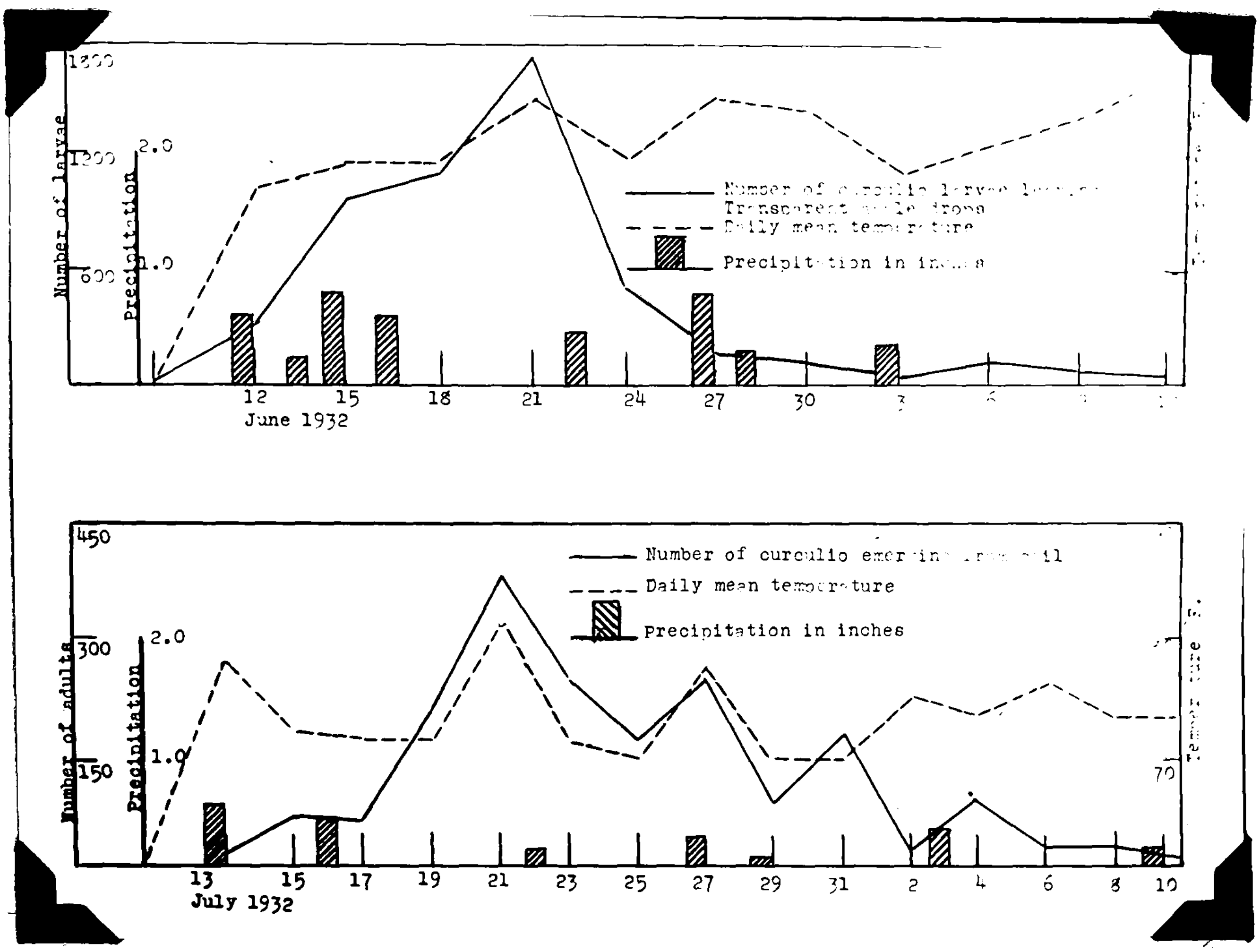
The relation of precipitation and the daily mean temperature to the emergence of curculio larvae from fruit drops and the adult curculio from the soil during 1930.

GRAPH XXI.



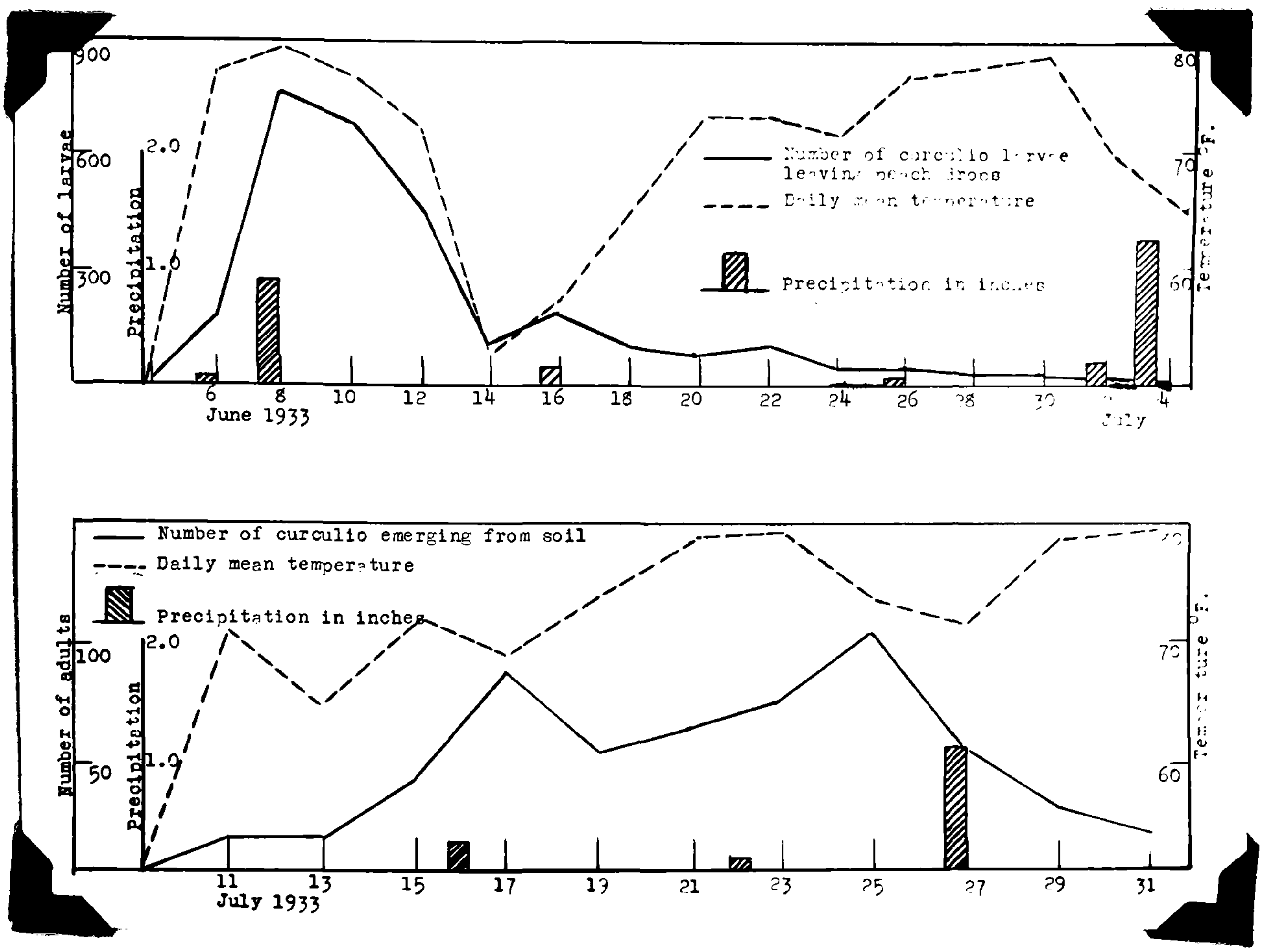
The relation of precipitation and the daily mean temperature to the emergence of curculio larvae from fruit drops and the adult curculio from the soil during 1931.

GRAPH XXII.



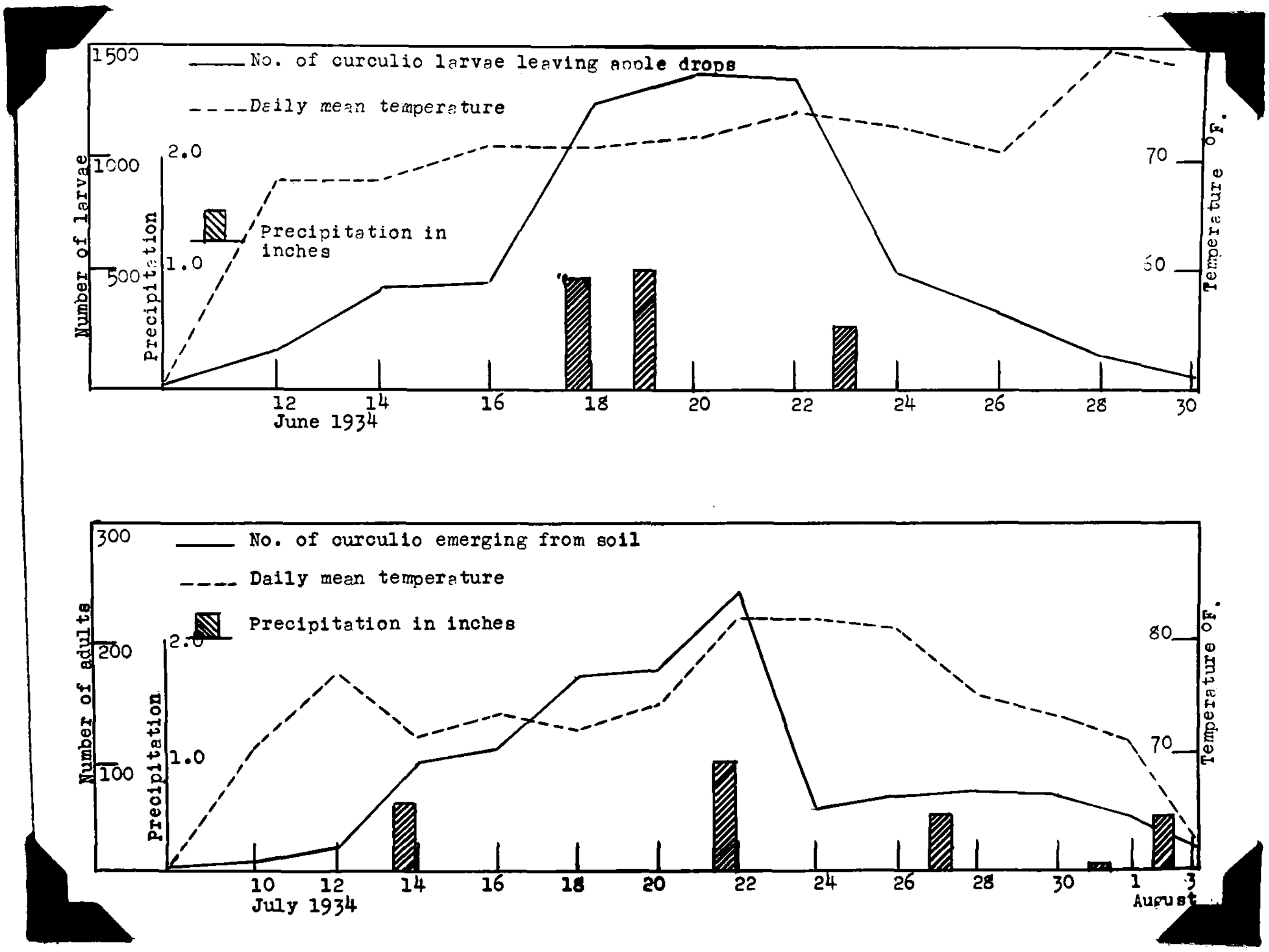
The relation of precipitation and the daily mean temperature to the emergence of curculio larvae from fruit drops and the adult curculio from the soil during 1932.

GRAPH XXIII.



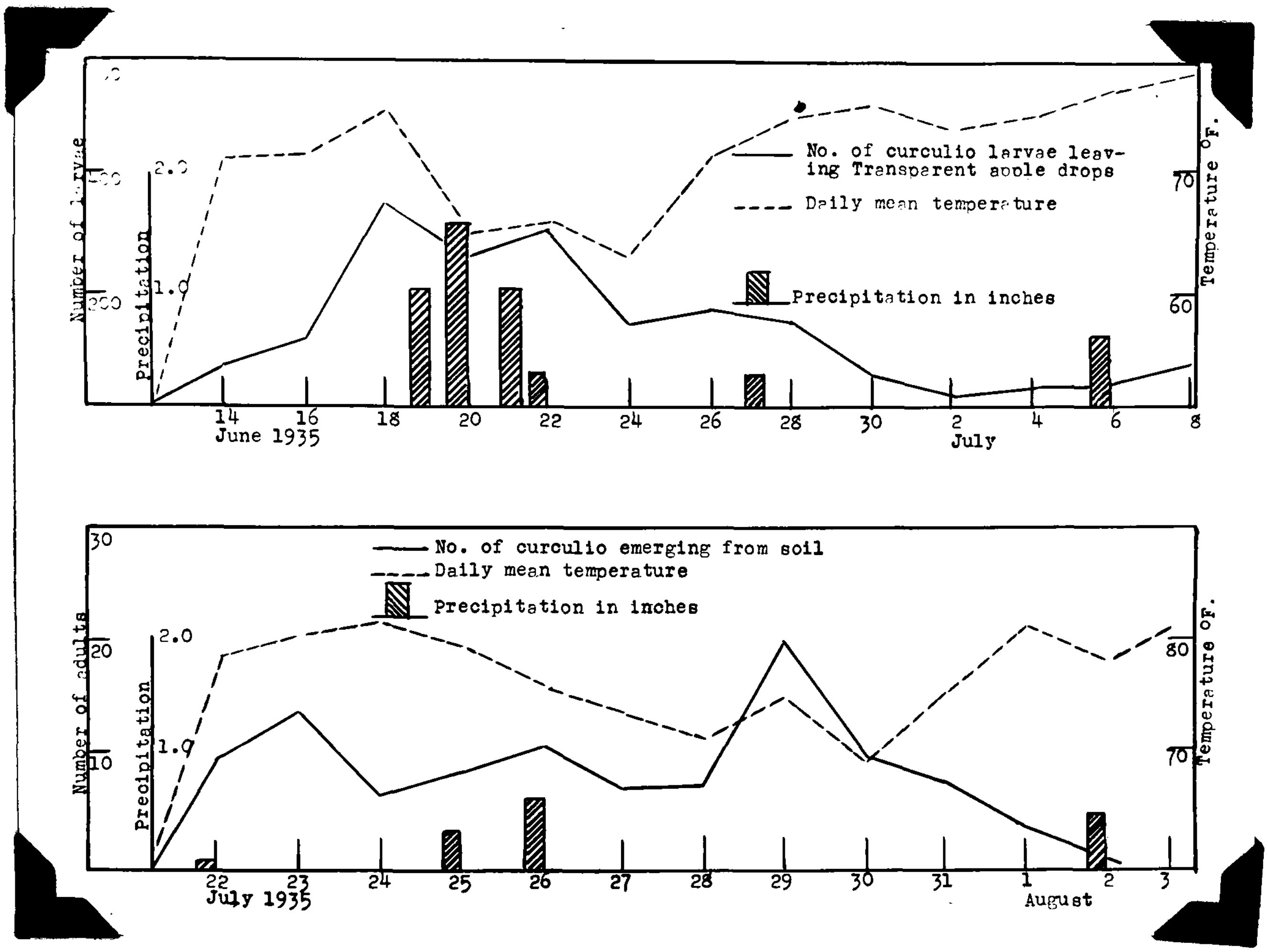
The relation of precipitation and the daily mean temperature to the emergence of curculio larvae from fruit drops and the adult curculio from the soil during 1933.

GRAPH XXIV.



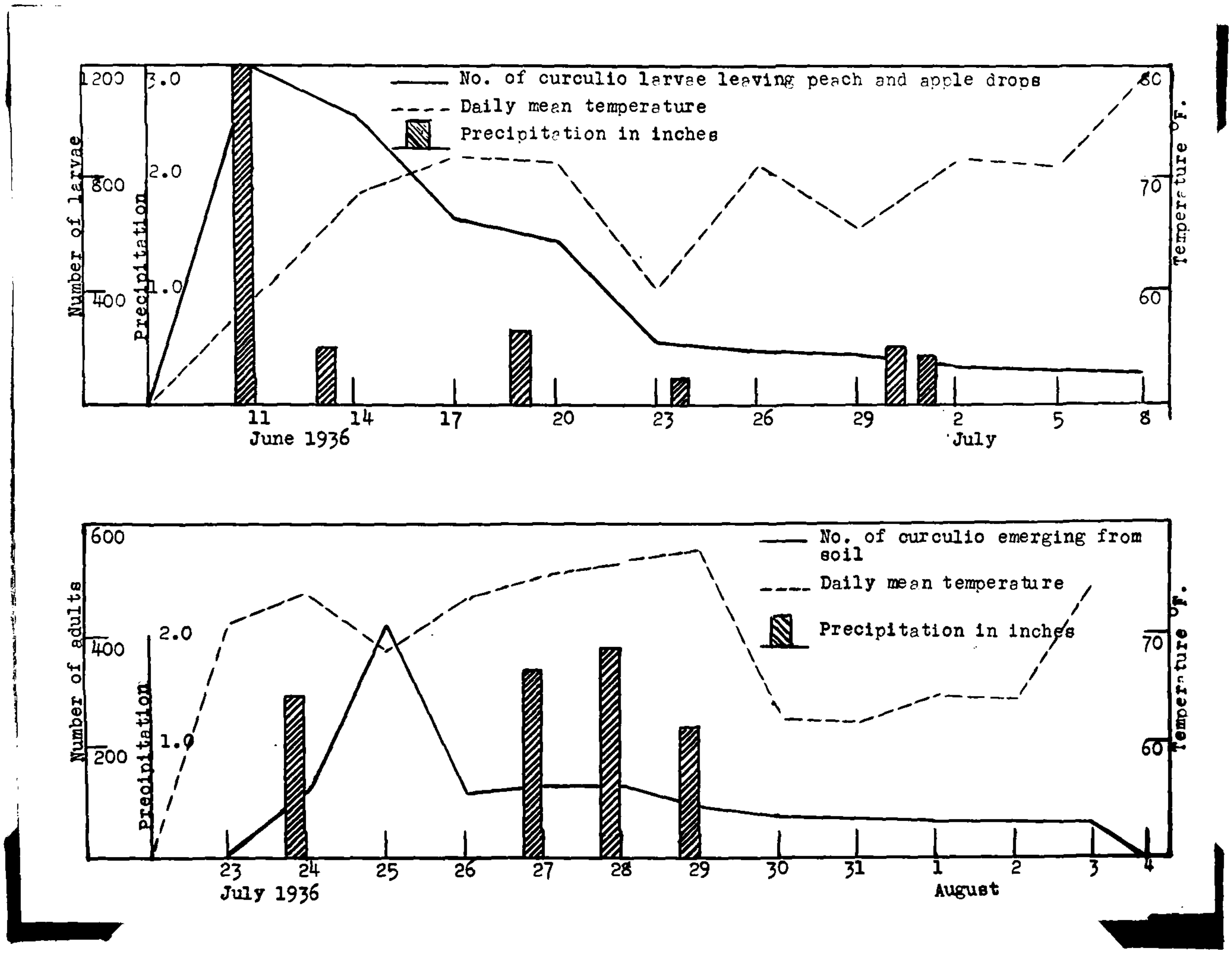
The relation of precipitation and the daily mean temperature to the emergence of curculio larvae from fruit drops and the adult curculio from the soil during 1934.

GRAPH XXV.



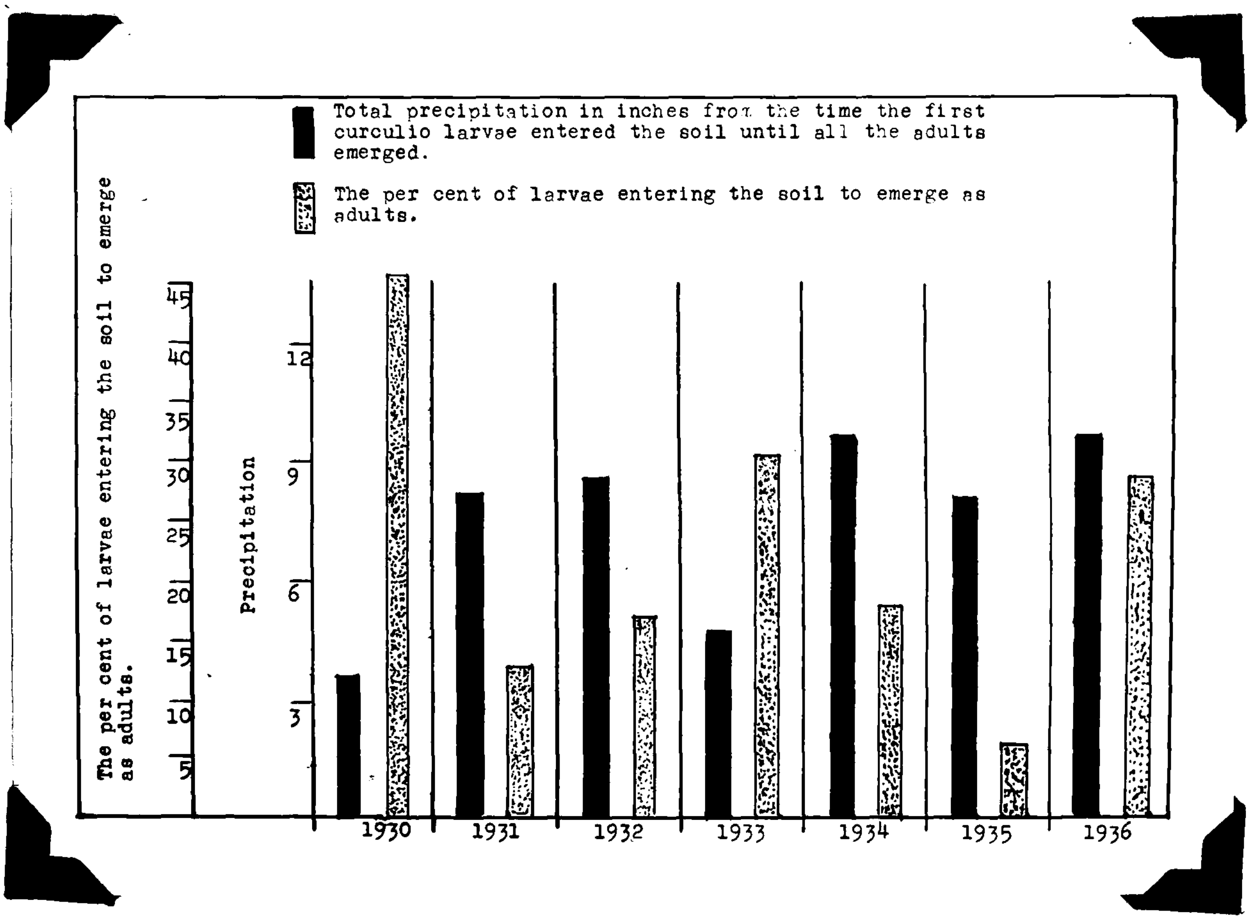
The relation of precipitation and the daily mean temperature to the emergence of curculio larvae from fruit drops and the adult curculio from the soil during 1935.

GRAPH XXVI.



The relation of precipitation and the daily mean temperature to the emergence of curculio larvae from fruit drops and the adult curculio from the soil during 1936.

GRAPH XXVII.



The relation of theper cent of curculio larvae to emerge as adults to the precipitation from the time the larvae enter the soil until all adults emerge.

DEPTH THE CURCULIO LARVAE BURROW INTO THE SOIL TO PUPATE

In 1930 tests were conducted to determine the depth larvae burrow into the soil to pupate. The experiments were conducted by placing curculio larvae in cages containing about 8 inches of soil and later carefully removing the soil in half inch layers and counting the pupal cells in each half inch. In one experiment 10.58% were found in the first half inch, 31.94% in the second half inch, 41.00% in the third half inch, 10.58 in the fourth half inch and 5.90 in the fifth half inch of the soil. In another test, 14.28% was found in the first half inch of soil. In another test, 14.28% was found in the first half inch, 50.00% in the second half inch, 28.57 in the third half inch, and 7.15 in the fourth half inch of soil.

These data show that in one experiment 72%, and in the other experiment 78% of the larvae pupate in the second and third half inch of the soil from the top. They were not found deeper than 2 1/2 inches in the soil.

VARIETAL PREFERENCE

During 1935 and 1936 tests were conducted to determine if the curculio had any preference for different varieties of apples before the young fruit was formed. Two apple trees, a Transparent and a York, were selected for the test. Each of the two trees were jarred for curculios from the time the buds showed pink until after all the curculios had emerged from their winter quarters. The York tree came into full bloom about 4 days after the Transparent tree, and both trees remained laden with blossoms for about 8 days at the same time.

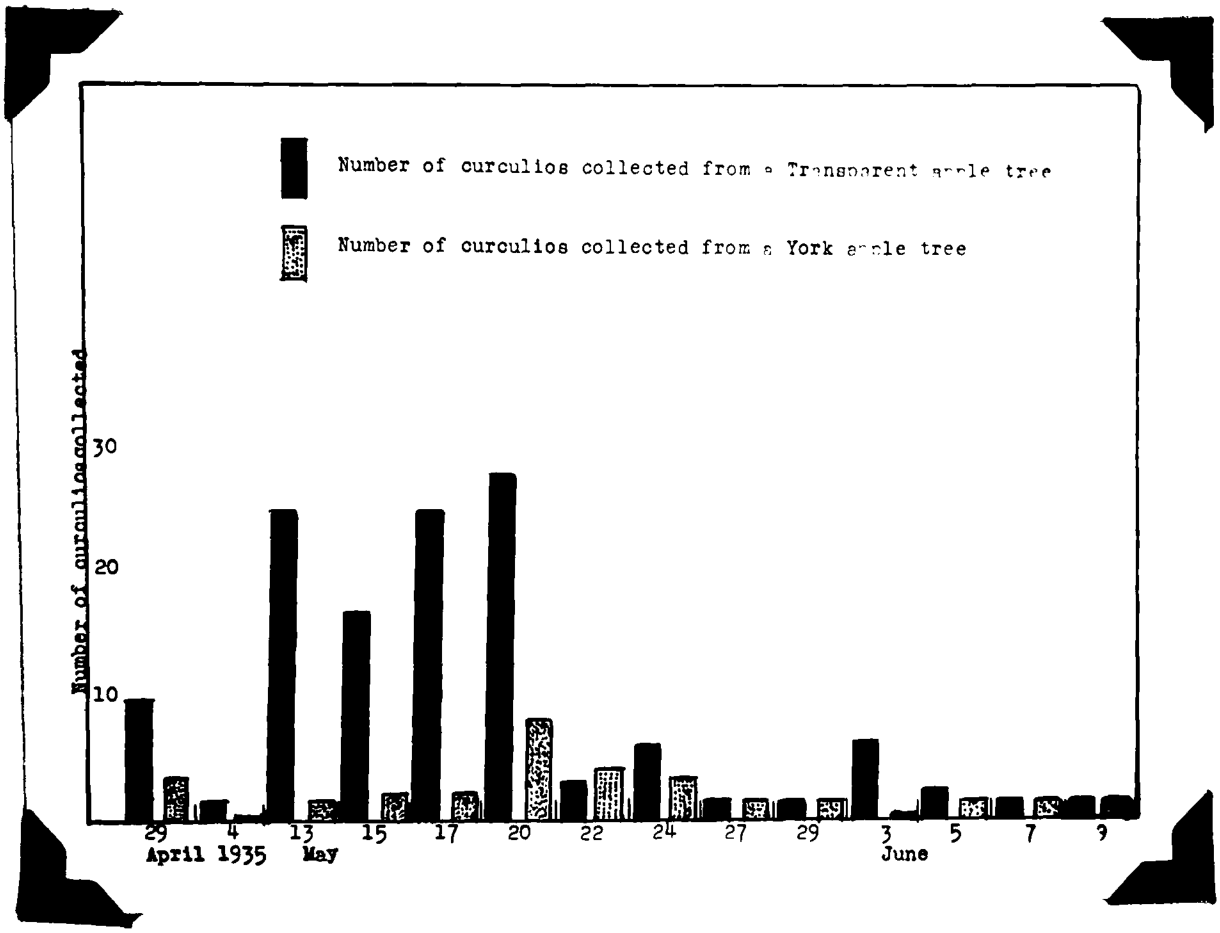
The tests in 1936 were carried on in the same manner as in 1935, with the York tree and the Transparent tree being in bloom at the same time over a period of 7 or 8 days. The records obtained show that in 1935 and 1936 the curculio was caught in significantly larger numbers from the Transparent tree than from the York tree, when both varieties were practically in full bloom at the same time.

It is generally known that after the apples are formed the curculios prefer the Transparent variety over the York, as the Transparent apples are soft fleshed and suitable for feeding and egg deposition. The hard fleshed varieties are not suitable for feeding and if the eggs are deposited in the apples they will be crushed by the growth of the fruit.

There is no satisfactory explanation for the curculio's preference of a Transparent apple to a York when both are in bloom at the same time. But the explanation is probably connected with the sense organs of the curculio and the odor of the blossoms.

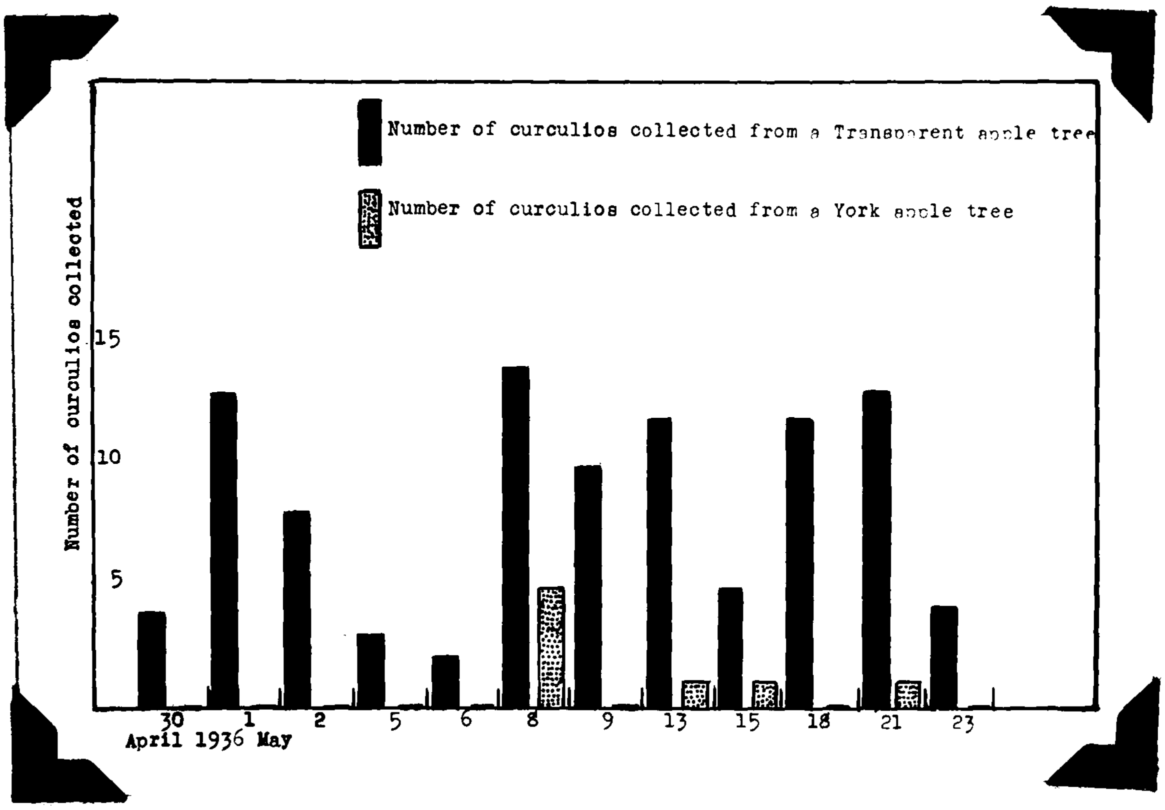
The number of curculios collected from each of the York and Transparent trees for 1935 and 1936 is shown in GRAPHS XXVIII and XXIX.

GRAPH XXVIII.



The number of curculios collected from a Transparent and a York apple tree when both trees were jarred on the same dates during 1935.

GRAPH XXIX



The number of curculios collected from a Transparent and a York apple tree when both trees were jarred on the same dates during 1936.

OBSERVATIONS ON FEEDING

Observations made in peach orchards early in the spring over a period of several years show that in addition to the sepals and petals of the fruit, the small tender leaves on shoots near the ground are a preferred food of the curculios. The curculios were observed feeding on the tender foliage, and many were collected from these sprouts during the period work was conducted on the curculio.

Laboratory observations on feeding were conducted by bringing in peach twigs containing peaches from 1/4 to 1/2 inch in diameter and placing the twigs in water to keep them fresh. Large lantern globes were placed over the twigs and the tops covered with cheese cloth to prevent the escape of the curculios.

Observations showed the heaviest feeding to be on the sepals, the next heaviest on the small peaches, (FIGURE 5) with some feeding on the tender leaves. In another test, with apple twigs containing both blooms and small apples, the petals were eaten first, the small apples next, with very slight feeding on the foliage even after the small apples and the petals were eaten away. In another test, peach, apple and cherry twigs were placed in with the curculios. Feeding was the heaviest on the sepals, small peaches, and tender leaves on the peach, the cherry foliage was eaten next heaviest, but no feeding on the apple.

Other tests were conducted in the same manner, using both sprayed and unsprayed foliage. In one test two apple twigs were used, one unsprayed and the other sprayed with a lead and sulfur solution. Observation, two days later, after the beetles were placed in the globe, showed an equal amount of feeding on both twigs, but after the second day there was practically no feeding on the sprayed twigs and slight feeding on the unsprayed. Most of the beetles left the twigs and went to the bottom of the lantern globe where they began to die in a few days. In another test two peach twigs, one unsprayed and the other sprayed with lead arsenate were used. Observation at the end of 24 and 48 hours showed an equal amount of feeding on each twig. At the end of 72 hours practically all the beetles had left the sprayed twigs and were either on the bottom of the lantern globe or feeding on the unsprayed twig.

Effects of spray on egg deposition

These tests were conducted by caging the beetles on a sprayed limb of a tree (FIGURE 6) and by placing sprayed twigs in a lantern globe, as previously described. Observations showed that in all cases the beetles continued to oviposit and feed heavily from 2 to 4 days, after which time oviposition apparently ceased and feeding became very slight. A few beetles were dead and apparently a few were sick after two days. This would indicate that after a poisonous spray has been applied to an orchard thousands of curculio eggs will be deposited before the beetles have consumed enough poison to stop their activities.

Field and laboratory tests with arsenical sprays and dusts in the control of the curculio

In 1932, several tests were carried on to determine the comparative efficiency of arsenate spray and dusts in the control of the curculio. The field tests were conducted by caging a certain number of curculios on a peach limb in a commercial orchard that had just received an application of spray or dust. The cage used was made out of screen wire in the shape of a cylinder, 24 inches in diameter, and 36 inches long. FIGURE 6. Cloth was sewed around each end so as to be tied around the limb to prevent the escape of the curculios.

The laboratory tests were conducted by bringing a sprayed material from the peach orchard and placing it in a cage in the insectary with the curculios.

In the field tests, records were taken after the curculios had been caged on the sprayed limb from 6 to 10 days. The average per cent dead in all dust applications, at the end of 6 days, was 48.15. The average per cent dead in all spray applications, at the end of 6 days, was 64.90. The average per cent dead in all dust applications, at the end of 10 days, was 76.6. The average per cent dead in all spray application, was 97.3. The data are shown in TABLE XIII.

In the laboratory tests, the average per cent dead in the dust test, at the end of 3 days, was 10. The average per cent dead in the spray test at the end of 3 days, was 50. The average per cent dead in the dust tests at the end of 6 days was 70. The average per cent dead in the spray test, at the end of 6 days, was 100. These data are shown in TABLE XIV.

The results obtained from these tests indicate that a lead arsenate spray is much more effective against the curculio than lead arsenate dust, and that with either dust or spray many of the curculios live for several days after feeding upon the fruit and foliage.

In other tests conducted, curculios were collected from a tree a certain number of days after the spray or dust was applied, and placed in a cage and fed on unsprayed foliage. The purpose of these tests were to determine if the curculios had consumed a killing dose of poison while feeding on the tree. There was nearly 50% mortality at the end of 30 days. The mortality on the beetles collected from the sprayed orchard was the heaviest. The results of these experiments are shown in TABLE XV.

Other tests similar to those in TABLE XV were conducted, but observations were not continued over a long period of time. The results of these tests are shown in TABLES XVI. and XVII.

TABLE XIII.

Field tests with arsenical sprays and dusts during 1932.

Material used	No. curculios used in test	Number dead in 6 days	Number dead in 10 days	Per cent dead in 6 days	Per cent dead in 10 days
90-10 dust	15	6	14	40	93.3
90-10 "	15	7	9	46.6	60.0
90-10 "	25	14	20	56.0	80.0
90-10 "	30	15	22	50.0	73.3
Lead Ars. 2 lbs. to 100 gals.	15	12	15	80.0	100.0
"	30	22	30	73.3	100.0
"	25	15	24	60.0	96.0
"	15	7	14	46.6	93.3

Average per cent dead in 6 days in all dust applications.48.15
Average per cent dead in 10 days in all dust applications76.65
Average per cent dead in 6 days in all spray applications64.9
Average per cent dead in 10 days in all spray applications97.3

TABLE XIV.

Laboratory tests with arsenical sprays and dusts during 1932.

Number curculios placed in cage	Spray material used	Per cent dead at the end of 3 days	Per cent dead at the end of 6 days
20	Ars. lead-2 lbs. to each 100 gals.	50	100
20	15% lead arsenate dust	10	70

Field tests with arsenicals

TABLE XV.

Orchard Number	Date sprayed	Material used	Date beetles were caged on tree	No. rains between time spray applied & time beetles placed on tree	Number beetles placed on tree	Per cent beetles dead at end of 10 days	Per cent beetles dead at end of 20 days	Per cent beetles dead at end of 30 days
1	May 9	10% Ar. dust	May 11	0	57	36.84	56.1	56.1
2	12	10% ar. dust	14	1	80	0.0	55.0	55.0
3	19	5% ar. dust	22	2	80	2.5	35.0	48.75
4	22	5% ar. dust	24	0	100	16.0	25.0	25.0
5	25	Lead ar. 2# to 100 gal spray	30	3	65	50.77	69.23	69.23

Field tests with arsenicals

TABLE XVI.

Date orchard was dusted	Date beetles collected & placed in cage	No. beetles placed in cage	% beetles dead at end of 2 days	% beetles dead at end of 4 days	% beetles dead at end of 10 days
May 8	May 13	50	0	6	52

Field tests with arsenicals

TABLE XVII.

Date orchard was dusted	Date beetles collected & placed in cage	No. beetles placed in cage	% beetles dead at end of 2 days	% beetles dead at end of 4 days	% beetles dead at end of 10 days
May 10	May 12	20	0	10	85

CONTROL FOR THE PLUM CURCULIO

The principal control measure in Maryland is spraying or dusting orchards with arsenicals, and burning woodland strips adjacent to the orchards.

Three applications of arsenicals are recommended. The first when three-fourths of the petals have fallen, or as advised by the spray service, the second when practically all the shucks are off the peach, and the third two weeks later.

The arsenicals applied as a spray is much more effective than when applied as a dust. It kills quicker and also kills a much larger percentage of the beetles. However arsenicals applied as a dust in orchards where the infestations are light have proved satisfactory.

The burning of wood edges, terraces, or any place suitable for hibernation of curculios has proven a great adjunct in curculio control. It has been shown that the population is decreased by 50% by burning the woods back for a distance of 300 yards. This method is practiced in many Maryland orchards and should be done when the trash and leaves are dry so as to reach the beetles that may be covered deeply with such debris.

Tree Jarring

This method of supplementary control is practiced in heavily infested orchards in the South but is recommended for Maryland only in exceptional cases as the infestations are not heavy enough to justify the cost of such a practice.

Removing Drops

The collecting and removing of early drops from the orchard is a great adjunct in decreasing the curculio population in heavily infested orchards. The overwintering curculios come into the orchard and deposit eggs in the small peaches and apples. A few days after the eggs are deposited the small fruit drops to the ground and within a week or so the larvae within reach maturity, leave the small fruit and enter the soil to emerge as adults later in the summer. If these drops are removed and destroyed it will greatly decrease the summer brood and in turn decrease the population the following spring.

The date on which the larvae first begin to leave the drops varies a few days from year to year. Therefore, no definite date can be set for collecting the drops. Six years of research shows that June 6 is the earliest date that larvae begin to leave the fruit, and June 14 the latest date. Therefore, if the drops are removed from the orchard before June 6 there is little possibility that any larvae would have left the drops. One additional collection about 10 days after the first is necessary where the infestation is heavy.

Cultivation

Cultivating orchards at the proper time kills many of the curculios that are in the soil. In order to get the greatest benefit from cultivation, it should be done at the time the greatest number of pupae are in the soil, for it is in this stage of development that the greatest number are destroyed by cultivation. Eight years of records on the time of emergence of the summer brood adults indicate that on an average the period during which the greatest number of pupae are in the soil at any one time is from July 8 to 18. Therefore, in cultivating the orchards the operations should be timed so as to obtain the best results possible in curculio control and at the same time not sacrifice any of the benefits to the orchard that is expected from cultural practices.

SUMMARY

I. Records over a period of eight years on the entrance of the curculio into peach and apple orchards show that the petals are falling from the peaches and that the apple trees are in full bloom before the first curculios enter the orchard. No curculios enter sprayed or cultivated orchards until from 1 to 3 days after the daily mean temperature is above 55°.

II. Records over a period of eight years show that the averages of the daily mean temperature from April 20 until the date on which approximately 50% of the curculios have entered the orchard range from 55° to 57° regardless of the date on which 50% have entered the orchard.

III. Records over a period of five years on the dispersion of curculios into the orchard show that they are present on trees near woodland areas and other suitable hibernating quarters from 3 to 14 days before they reach the center of the orchard, and that the infestation is never as heavy away from their hibernating quarters as it is near it.

IV. Records on the egg deposition of the curculio show that the curculio will begin oviposition as soon as they leave their hibernating quarters if a suitable oviposition medium is present. The minimum number of eggs deposited by a single female curculio at Hancock, Md., during 1935, under laboratory

conditions, was 34, the maximum number was 92, with an average of 55.3. In 1936 the minimum number of eggs deposited by a single female curculio was 17, the maximum number was 82, with an average of 40.5.

V. The incubation period of the curculio egg in 1930 varied from 12.5 days in the early spring to 5.5 days later in the summer. In 1931 the incubation period of the curculio egg varied from 14 days in early May to 9 days later in May.

VI. The length of time spent in fruit by the egg and larva of the curculio ranged from 21 to 29 days with an average of 24.09 days.

VII. The length of time spent in the soil by the larvae of the curculio ranged from 9 to 20 days with an average of 12.92 days. The length of time spent in the soil by the pupae of the curculio ranged from 7 to 15 days, with an average of 10.72 days.

VIII. The length of time spent in the soil by all stages of the curculio ranges from 26 to 60 days with an average of 36.30 days for all tests.

IX. The average length of time, over a period of several years, from the date the eggs were deposited until the curculios emerged from the soil was 60.99 days.

X. Records over a period of six years show that the date on which curculio larvae start leaving the fruit drops ranges from June 6 to June 14, with emergence continueing until late in July. Seven years records show that the first curculio emergence of the summer brood ranged from July 10 to July 24, with emergence continueing until the middle of August.

XI. The percentage of larvae that enter the soil to emerge as adults depends to a large extent upon the precipitation during July. If the precipitation is light a greater per cent of larvae will reach maturity than if the rainfall is heavy.

XII. Records taken on the depth that curculio larvae burrow into the soil to pupate show that approximately 75% of them pupate in the 2nd and 3rd 1/2 inch of the soil from the top, with none going deeper than 2 1/2 inches

XIII. Tests on varietal preference show that curculios have a great preference for yellow Transparent apples over York Imperial apples, even in the blooming period, when both varieties are in full bloom at the same time.

XIV. When curculios first enter the peach orchard in the spring they feed heavily on the tender foliage of the water spouts near the ground, and other tender foliage in the tree. Later they feed on the petals, sepals and then on the fruit.

XV. Curculios will continue to deposit eggs from 2 to 4 days after being confined in a cage and feed on commercial sprayed peach and apple foliage, blossoms and fruit.

XVI. Field tests with arsenical dusts and sprays show that arsenical sprsys are much more effective in the control of curculios than arsenical dusts.

XVII. Control methods in Maryland consist of applying three arsenical sprays, one at the petal fall stage, one when two-thirds of the peaches are exposed from the shuck, and the third two weeks later. Supplementary control methods consist of burning woodland, fence rows, etc., near the orchard to kill overwintering curculios, and to cultivate between July 8 and 18 to kill the pupae of the curculio.

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FIGURE I.

Sheet spread under peach tree ready for collecting curculios.

FIGURE 2

Stage of peach tree at the time the first curculios were collected.

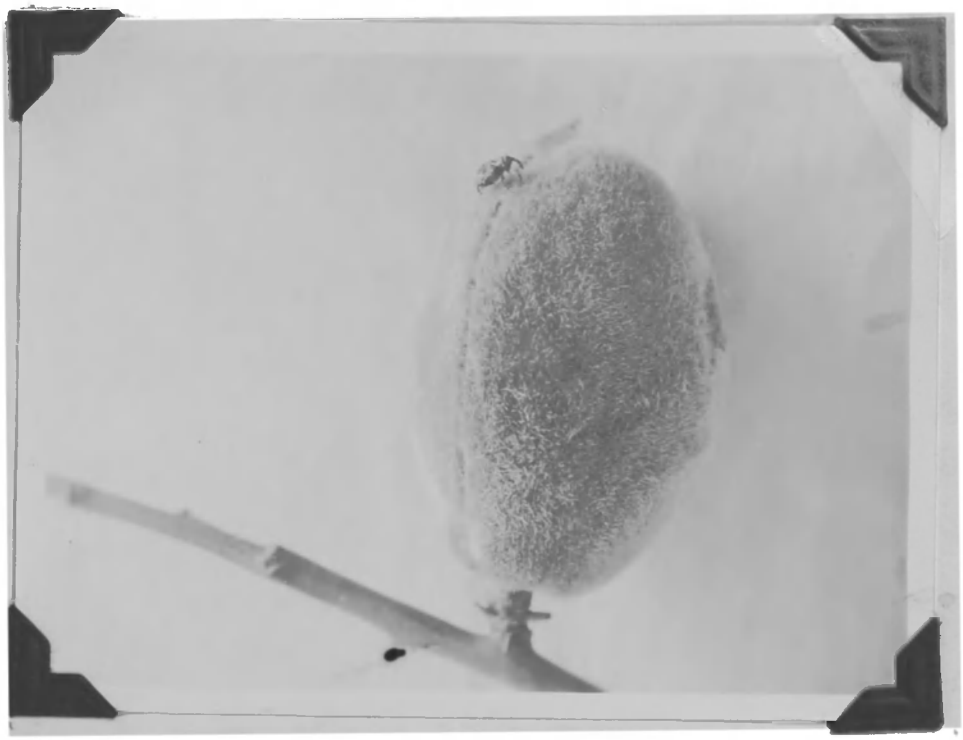
FIGURE 3

Stage of Transparent apple tree at the time the first curculios were collected.

FIGURE 4

Stage of York Imperial apple tree at the time the first curculios were collected.

FIGURE 5.



Adult curculio on peach.

FIGURE 6.

Cage used in enclosing curculios on sprayed foliage.

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